1985 CB ANNUAL REPORT

SUMMARY OF DEVELOPMENT ACTIVITIES, COSTS AND ENVIRONMENTAL MONITORING

CATHEDRAL BLUFFS SHALE OIL COMPANY

751 HORIZON COURT

GRAND JUNCTION, COLORADO 81501

APRIL 30, 1986

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April 30, 1986

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FOREWORD

The 1985 CB ANNUAL REPORT is submitted to fulfill the requirements ofwOil Shale Lease Number C-20341 as stated in Section 16(b) of the Lease, Section 1.(C)(4) of the Lease Environmental Stipulations, and Condition of Approval No. 3 of the Detailed Development Plan issued on August 30, 1977.

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1985 CB ANNUAL REPORT

SUMMARY OF DEVELOPMENT ACTIVITIES, COSTS AND ENVIRONMENTAL MONITORING

1.0 INTRODUCTION AND SUMMARY

This report summarizes the development activities, costs and environmental monitoring on the Federal Oil Shale Lease Tract C-b during calendar year 1985. The Tract is leased to Cathedral Bluffs Shale Oil Company under U.S. Department of the Interior Lease Number C-20341. Cathedral Bluffs Shale Oil Company is an equal-interest partnership between Occidental Oil Shale, Inc. and Tenneco Shale Oil Company. The Tract is located in Rio Blanco County in the Piceance Creek basin of northwestern Colorado.

Cathedral Bluffs Shale Oil Company (CBSOC) history and status through 1985 are summarized on Table 1-1. CBSOC has been actively pursuing development of a viable oil shale mining and retorting project; the activities which have occurred are necessary for the Project's development.

Project expenditures in 1985 were $7,119,000.

Principal activities on-tract in 1985 were primarily maintenance and monitoring related.

Routine maintenance and inspection on all facilities, headframes, shafts and hoists was performed as scheduled. Minor construction work of a maintenance nature was also performed. This included realignment of the main cage guide steel and re-enforcement of the main cage crosshead structure.

Modifications were made to the pump station at the bottom of the production shaft. This involved upgrading and relocating the electrical system and hard piping to improve servicability and performance.

Environmental monitoring continued as provided for under the Interim Monitoring Plan.

TABLE 1-1

C-b Tract Chronology

1974

C-b Lease C-20341 signed.
Two year Environmental Baseline Program started.
Extensive coring program started.

1975

Environmental baseline monitoring and coring continued; cores converted to water monitoring wells.

1976

Detailed Development Plan submitted and approved in February by OSPO (surface retorting).
Two year Environmental Baseline Program completed.
Lease suspension period commenced.

1977

Lease suspension period ended.
Modified Detailed Development Plan submitted and approved in February by OSPO (Modified In-Situ retorting).
Site preparation activity initiated.
PSD permit issued by EPA for MIS Ancillary Facilities (12/15/77).

1978

Commenced construction of Project facilities (in accord with EPA PSD permit) by setting collars for each shaft - 15 ft. V/E shaft, 29 ft. production shaft, 34 ft. service shaft.
Construction of headframes for all three shafts was completed.
Cement batch plant became operational.
Work began on water management system - two five-acre holding ponds - A and B.
Development Monitoring Plan completed and implemented.

1979

Sinking of the production, service and V/E shafts commenced.
Completed holding ponds A & B and commenced treatment of water for discharge under NPDES permit.
Hydrologic monitoring expanded for Water Augmentation Plan in accord with Court Decree.

1980

Sinking of the three shafts continued.
Continued utilization of the water management system; completed construction of sprinkler irrigation system, additional water treatment facilities; and commenced testing sprinkler irrigation methods.
Five offices, two labs constructed.
Submitted proposal for financial assistance to DOE (Nov.) under the Federal Non-Nuclear Research and Development Act.

1981

Sinking of the three shafts completed.
Outfitting of the production and service shaft headframes commenced.
Water management system expanded to include holding pond C and reinjection system. Complete system operational. Reinjection testing completed. Discharge under NPDES permit continuing.
Three contractor's offices added along with mine power substation, natural gas supply building, sewage treatment plant, slabs for both changehouse and warehouse buildings, manway tunnels, and utility tunnels.
Dewatering of V/E shaft was discontinued following OSPO approval.

TABLE 1-1 (Cont'd)

1981

CBSOC announced that Project was to be reassessed; major plan construction was put on hold.

1982

Construction activities were reduced while Project planning and economics were reassessed.

Intense Project activity to prepare three proposals to Synthetic Fuels Corp. (SFC) for revised scope (submitted in 1983).

Continued outfitting of headframes of service and production shafts for hoisting.

Continued use of water management system to treat mine water for reinjection or discharge under NPDES permit.

Completed the control room (for hoists), airlocks, and mechanical/electrical shops.

Completed construction of on-Tract power substation and it became operational.

Submitted application to EPA for PSD amendment to modify permitted facilities by constructing 12,000 bpd aboveground retort and 15,000 bpd oil upgrading plant.

CB participated in procedures to finalize construction of by-pass highway around City of Rifle.

Although no new acreages were disturbed, two drill pads of 0.5 acre each were revegetated.

1983

Proposal for financial assistance submitted to SFC in January; scope of this Project was to produce 14,100 bbls per calendar day of shale oil, and included:

1) One commercial scale aboveground retort (AGR) using the Unishale B process;
2) Four continuously burning MIS retorts;
3) Room-and-pillar and MIS mining;
4) Oil upgrading facility.

Letter of Intent received from SFC in July to provide up to $2.19 billion in support for Project.

Project Level II/Level III Design and Cost Estimates completed.

Commissioning of the production, service and auxiliary hoists completed.

Continued mine dewatering and use of water management system to treat mine water for discharge under NPDES permit.

Continued geotechnical program to obtain ore sample for Union retort tests and to assess fines generation and to obtain additional core samples for further resource evaluations.

PSD permit issued by EPA in September for modification to permitted facility by constructing 12,000 bpd retorting and 15,000 bpd oil upgrading facility.

Completed installation of the automated mine gas monitoring system.

Work was initiated on a Revised Detailed Development Plan (RDDP) and on a Mined Land Reclamation Permit to reflect the 14,100 bbl/day Project.

Contractor initiated work to perform tests to characterize CB Unishale spent shale so as to define proposed design of spent shale embankment.

New acreages which were disturbed from six drill pads consisted of 3 acres; no new acreages were revegetated.

A spent shale revegetation demonstration plot utilizing C-b shale retorted by the Union B process was constructed.

TABLE 1-1(Cont'd)

1984

Continued Project negotiations with the SFC:
1) SFC Board notified U.S. Treasury to set aside Loan and Price Guarantees for CBSOC (April);
2) SFC Board members step down, and as a result a quorum no longer exists;
3) Work continued with SFC staff in preparing a draft Information Memorandum;
4) Work continued on negotiating a Committment to Guarantee;
5) New SFC Board members were appointed (December); a quorum was re-established;
6) No contract was secured with SFC in 1984.

Submitted first draft of Revised Detailed Development Plan (RDDP) in February to OSPO.
Presented RDDP to Oil Shale Environmental Advisory Panel (March).
Completed CB/USBM cooperative drilling program to study methane emanation rates in oil shale.
Initiated construction to provide space for a hoist control room.
Continuing program of mining bulk ore samples for testing.
Continued preparation of final draft of RDDP; issuance delayed pending Project definition.
AGR Design Test Run for CB received from Union Oil Company (May).
Completed major upgrading and rebuilding of the underground mine electrical system and pump stations.
Initiated work on raw and spent shale leaching studies.
A natural gas pipeline was installed on Tract from the main-line termination point near the generator building to the shaft heater and maintenance shop area; natural gas then replaced propane for the shaft heater.
Raw and spent shale characterization report completed (September).
A second spent shale revegetation plot was constructed (summer) and seeded (October).
No new acreages were disturbed; 6 corehole drillpads were reclaimd.
Spent shale disposal test work report drafted; modifications in process.
Continuing mine dewatering and use of water management system to treat water for discharge under NPDES permit.
Continuing engineering and project cost studies.
Continuing CB site operation and maintenance.

1985

Continued Project negotiations with the SFC:
1) Submitted alternate project configurations for SFC consideration (April);
2) House of Representatives voted to abolish SFC - 312 to 111 (July);
3) Negotiated and submitted phased project development at SFC request (October);
4) Motion to table Metzenbaum Senate amendment to kill SFC failed - 41 to 58 (October);
5) Submitted two additional options at SFC request (November);
6) Submitted revision to options at SFC request (December);
7) Interior appropriation bill tabled (December 4);
8) Metzenbaum amendment to kill SFC was defeated by Senate vote - 43 to 40 (December 6);

TABLE 1-1(Cont'd)

1985(cont'd)

9) Letter sent by White House Budget Director James Miller asking Congress to rescind all SFC funding (December 12);

10) Joint House-Senate Conference Committee included wording in appropriations bill to remove funding and dissolve SFC (December16);

11) President Reagan signed Public Law 99-190, which provided as part of overall appropriations, for termination of U.S. Synthetic Fuels Corporation within 120 days and rescinding all funds not committed.

Received contingency planning study from Bechtel (April).

Completed work on project configuration with Fluor and Bechtel (April).

Received mining cost engineering estimate from Cleveland Cliffs (May).

Completed review comparing CB engineering estimate against Cleveland Cliffs estimate.

Occidental signed purchase option agreement with Tenneco for Tenneco's interest in CB partnership (October).

Began detailed review of options for continued development of CB Project (December).

Continued mine pumping and use of water management system for discharge under NPDES permit.

Continued CB site operation and maintenance.

Water make for the shafts was as follows:

Shaft	Total for 1985 (million gal)	Cumulative Total To Date (million gal)
Ventilation/Escape	0	679.0
Production and Service	183.5	1429.5
TOTAL	183.5 (201.5)	2108.5 (1925)

Quantities for 1984 are shown in parentheses.

* An additional 18 million gal have been pumped from small wells for on-Tract use bringing the grand total to 2126.5 million gal.

The approved inactivation of the ventilation/escape (V/E) shaft dewatering system in September 1981 continiued through 1985.

The 1985 water management was achieved via direct discharge from on-tract holding ponds under the NPDES permit. Following the inactivation of the V/E shaft and subsequent declines in dewatering rates the reinjection mode was temporarily discontinued in July 1982. To summarize for the year 1985:

147.6 million gallons were discharged,
0.0 million gallons were reinjected,
0.0 million gallons were sprinkler irrigated,
2.2 million gallons were used or stored,
33.7 million gallons were lost to evaporation and seepage, and
183.5 million gallons were pumped.

There were no areas of new disturbance in 1985. Total disturbed acreage remains at 191 acres. Six drill pads of the 1983 core sampling program were reclaimed in 1984 corresponding to 3 acres, bringing the total reclaimed acreage to 38.

Regarding environmental and health protection and control, in addition to water management already discussed, the following should be noted:

- Regarding air emissions, the cement batch plant ceased operation in 1982 and remained out of operation through 1985.

- No substantial degradation in visual range has been noted since inception of the visibility program in 1975; none is judged to be due to CB.

- A 9,000 gal/day capacity sewage treatment plan ceased operation in March of 1982 and remained out of operation in 1985. At present, the sewage is being disposed via porta-johns; and an approved sewage system that has been in operation for nine years is utilized to dispose of that from the C-b offices.

- Zero reportable accidents in 41,166 man hours on-Tract during 1985 resulted in an accident incident rate of 0.0. A program continues of training, job safety analysis, and frequent safety meetings to maintain this zero accident rate.

- Special reflectors, installed along four one-mile sections of Piceance Creek Road in 1981 as a mitigation test to reduce deer road kill, continued to be used from 1982 through 1985. Fewer deer are killed where reflectors are used.

Regarding socioeconomic impacts, the 1985 CB workforce on-tract decreased from a year-end level of 17 in 1984 to a year-end level of 7 in 1985. Total persons employed directly by CB, including Grand Junction staff, decreased from 61 in December 1984 to 23 in December 1985. In mid-November of 1983, CB submitted a Major Development Permit Applicatin to Rio Blanco County. Discussions over socioeconomic mitigation plans continued during 1984 and 1985 with Rio Blanco and Garfield counties. Final agreement on these plans was not reached.

Environmental monitoring has continued as an ongoing activity at the Tract since the completion of the two-year Baseline period (1974-1976). It encompasses, air, water, biology, and health and safety. Results are summarized in Section 9 of this volume. No significant environmental impacts have been noted to date except for areas directly disturbed by drilling, construction, ponds, and mined rock disposal, drawdown of groundwater levels from mine dewatering, some vegetation effects in previously sprinkler-irrigated areas, and increasing fluoride values in one spring (north of the Tract).

The following project abbreviations appear in this report:

CB - for Cathedral Bluffs, and
C-b - for Colorado-b Federal Oil Shale Lease Tract.

2.0 DESCRIPTION OF PROJECT AREA

2.1 Location

No change in status from last year.

2.2 Legal Description of the Leased Land

No change.

2.3 Leasehold Status

No change.

3.0 PROJECT STATUS, SCHEDULE AND COSTS

3.1 Project Status

CB Shale Oil Company (CBSOC) history and status through 1985 are summarized on Table 1-1, including recent Project proposed configurations and negotiations with the Synthetic Fuels Corporation (SFC). In 1985 CBSOC continued toward development of a viable oil shale mining and retorting project. In October of 1985, Tenneco granted Occidental a two-year option to purchase Tenneco's 50 percent interest in the CB partnership. During the option period Occidental will be the operator.

CB continued discussions with the SFC Board through December to seek SFC financial assistance. On December 19, 1985, President Reagan signed public law 99-190, terminating the Synthetic Fuels Corporation.

Occidental consequently initiated a detailed review of its options for continued development of the CB Project at the end of 1985. Concurrent with that review, routine maintenance and monitoring will continue in 1986.

Status of the Project with regard to environmental protection and control and permitting is summarized in Section 7.0.

3.2 Schedule

The OSPO approved "Milestone" or Project Guide Schedule (as approved in 1978) has appeared in all past Annual Reports. Due to project uncertainties, it will not be repeated at this time. This schedule has been modified by subsequent OSPO action as follows:

- An interim operation plan was approved on September 1, 1981, which allows the V/E Shaft to fill with water until it is necessary to draw down the water for mine development.

- An Interim Monitoring Program was approved on March 17, 1982 (Rutledge, 1982a) and revised on July 22, 1982 (Rutledge, 1982b) to reflect the reduced level of activity on Tract through March 1983. The Interim Monitoring Program has recently been extended into 1985 until such time as a Revised Detailed Development Plan is approved.

- An Interim Development Program and Schedule was approved on July 22, 1982 (Rutledge, 1982c) to reflect the reduced level of activity commensurate with the December, 1981 announcement by CB management that the entire project was being reassessed due to oil prices, interest rates and project costs. Further extensions were granted in 1983 and 1985 (Hoffman, 1983a and 1983b) and (Carie, 1985).

As in 1984, on-Tract activities in 1985 were significantly reduced; on-site construction in 1985 has been delineated in Table 1-1. The major contractors on-tract are noted in Table 3-1.

3.3 Costs

Financial information for 1985 is presented in Table 3-2 for the following categories: mine capital, surface capital, and unallocated support. Total expenditures for the year were $7,119,000.

TABLE 3-1

1985 Major Contractors and Responsibilities

Bechtel	Project definition studies
Schmueser & Associates	Operation and maintenance labor
Fluor	Project definition studies
Mariah Associates	Aquatic sampling
Stearns-Catalytic	Project definition studies
Stoecker-Keammerer & Associates	Vegetation and wildlife monitoring
U.S. Bureau of Mines	Dust explosivity studies
In-Situ, Inc.	Spent shale disposal studies
Crane & Associates	Socioeconomic monitoring
Cleveland Cliffs	Mining Cost Estimate
Colorado Well Service	Well Recompletion
Dave Newell	Well Engineering Design

TABLE 3-2

1985 CB Expenditures
(Thousands of $'s)

MINE CAPITAL			
Plant Services			$ 1273
SURFACE CAPITAL			
Engineering Capital			232
UNALLOCATED SUPPORT			
Engineering		1652	
Administration		2726	
Environmental			
Staff	$ 629		
Air Monitoring	19		
Water Monitoring	108		
Biology/Reclamation	48		
Permits	12		
Water Supply	66		
Reports	9		
Computer Service	69		
Laboratory	20		
		982	
Socioeconomic		50	
Ad Valorem Tax		206	
			5619
TOTAL			$ 7119

4.0 DEVELOPMENT ACTIVITIES

4.1 On-Tract Facilities Description

4.1.1 General Arrangement

Activities in 1985 consisted primarily of maintenance of all site facilities and minor construction modifications to existing installations. Material laydown areas all over the site were condensed and cleaned up. No new buildings or any structures or facilities have been constructed in 1985.

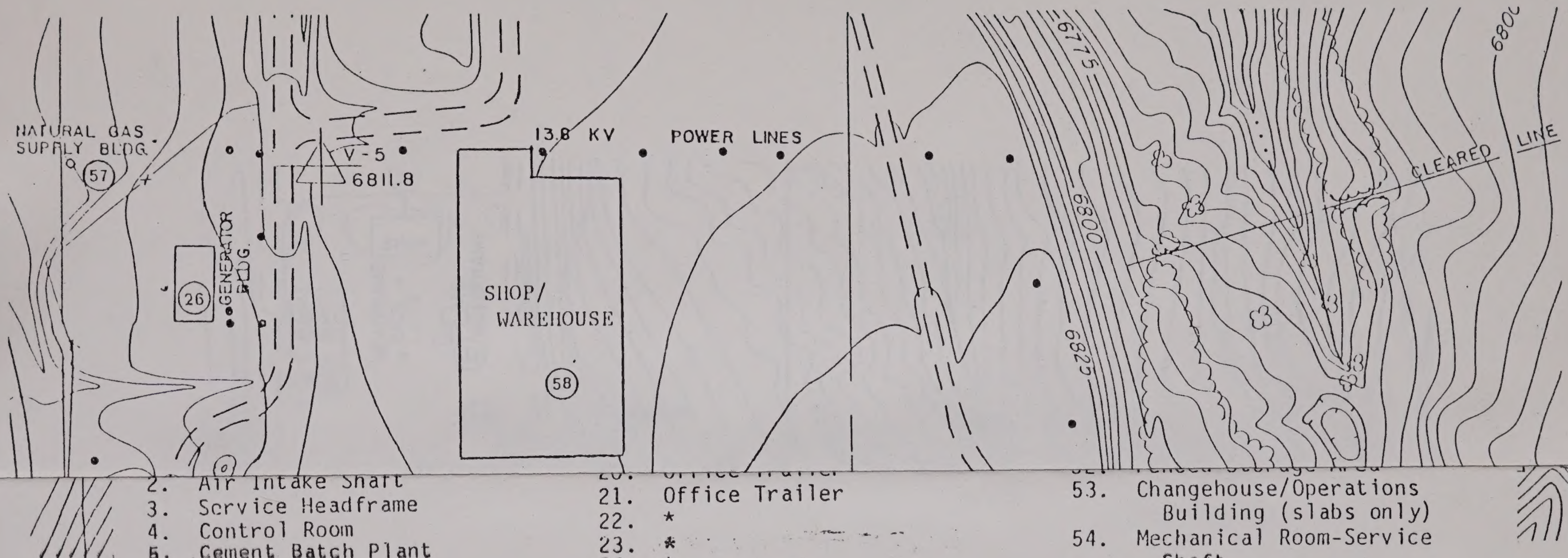
An explosion and fire damaged the Western Slope Gas Company building on tract, just north of the emergency generator building. Western Slope Gas Company rebuilt the facility.

Existing on-tract facilities are shown in the following figures:

° Figure 4-1: C-b Tract Topographic Map (Jacket Map)
° Figure 4-2: Mine Support Area
° Figure 4-3: V/E Shaft and Ponds A & B
° Figure 4-4: Guard Building and Heliport
° Figure 4-5: Pond C Area
° Figure 4-6: Explosives Storage Area

Table 4-1 is the key to the numbers shown on Figures 4-1 through 4-6.

Facilities that were removed in previous years have been taken off the figures and the numbering sequence starred (*) to indicate this. These figures should be compared with those of previous years for description of removed facilities. Site facilities are being maintained until construction activities are resumed.



2. Air Intake Shaft
3. Service Headframe
4. Control Room
5. Cement Batch Plant
6. Cement Batch Plant Aggregate Storage
7. Office Complex
8. Emergency Vehicle Bldg.
9. First Aid Trailer
10. Mine Rescue Trailer
11. Shop
12. Offices
13. Dry
14. Parking Area
15. Main Warehouse
16. Fuel Storage Facilities
17. Warehouse
18. Topsoil Storage Area
19. Storage Building

21. Office Trailer
22. *
23. *
24. *
25. *
26. Generator Building
27. *
35. *
36. Paved Main Access Road
37. Generator
38. Storage Yard
39. Environmental Storage Bldg.
40. Shale Disposal Area
48. *
49. Hydrology/Air Laboratory
50. Soils Lab

53. Changehouse/Operations Building (slabs only)
54. Mechanical Room-Service Shaft
55. Mine Support Area Substation
57. Natural Gas Supply Bldg.
58. Warehouse/Maintenance Shop (slabs only)
59. Manway Tunnel from Changehouse to Service Headframe.
60. Utility Tunnels from Substation to Service/Production Headframes and Changehouse
61 *

* = Building removed in previous years

Figure 4-2

Topographic map showing facilities in the Mine Support Area

1. Production Headframe
2. Air Intake Shaft
3. Service Headframe
4. Control Room
5. Cement Batch Plant
6. Cement Batch Plant Aggregate Storage
7. Office Complex
8. Emergency Vehicle Bldg.
9. First Aid Trailer
10. Mine Rescue Trailer
11. Shop
12. Offices
13. Dry
14. Parking Area
15. Main Warehouse
16. Fuel Storage Facilities
17. Warehouse
18. Topsoil Storage Area
19. Storage Building
20. Office Trailer
21. Office Trailer
22. *
23. *
24. *
25. *
26. Generator Building
27. *
35. *
36. Paved Main Access Road
37. Generator
38. Storage Yard
39. Environmental Storage Bldg.
40. Shale Disposal Area
48. *
49. Hydrology/Air Laboratory
50. Soils Lab
51. *
52. Fenced Storage Area
53. Changehouse/Operations Building (slabs only)
54. Mechanical Room-Service Shaft
55. Mine Support Area Substation
57. Natural Gas Supply Bldg.
58. Warehouse/Maintenance Shop (slabs only)
59. Manway Tunnel from Changehouse to Service Headframe.
60. Utility Tunnels from Substation to Service/Production Headframes and Changehouse
61 *

* = Building removed in previous years

Figure 4-2

Topographic map showing facilities in the Mine Support Area

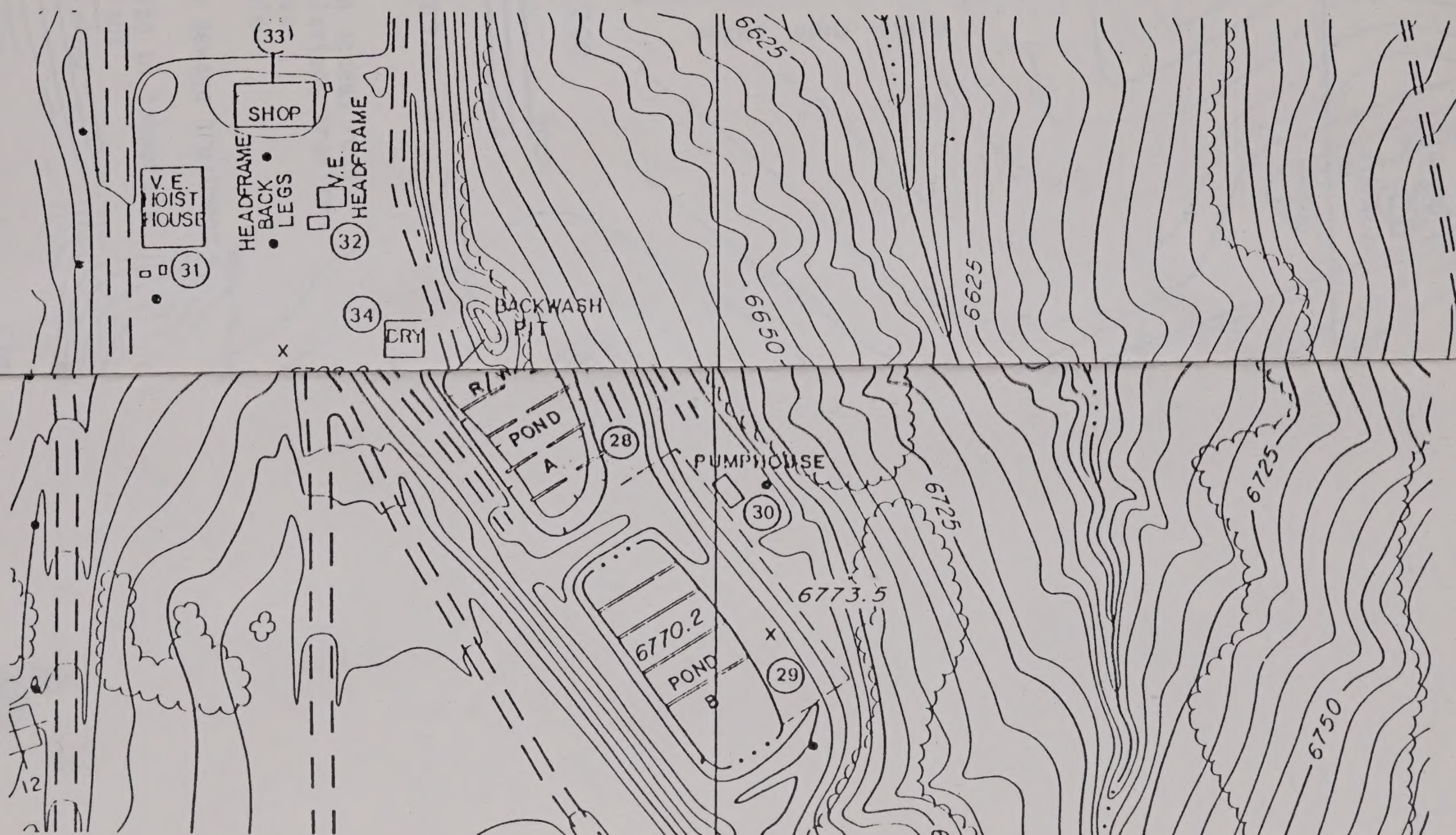


Figure 4-3

Topographic map showing facilities near the V/E Shaft and Ponds A and B

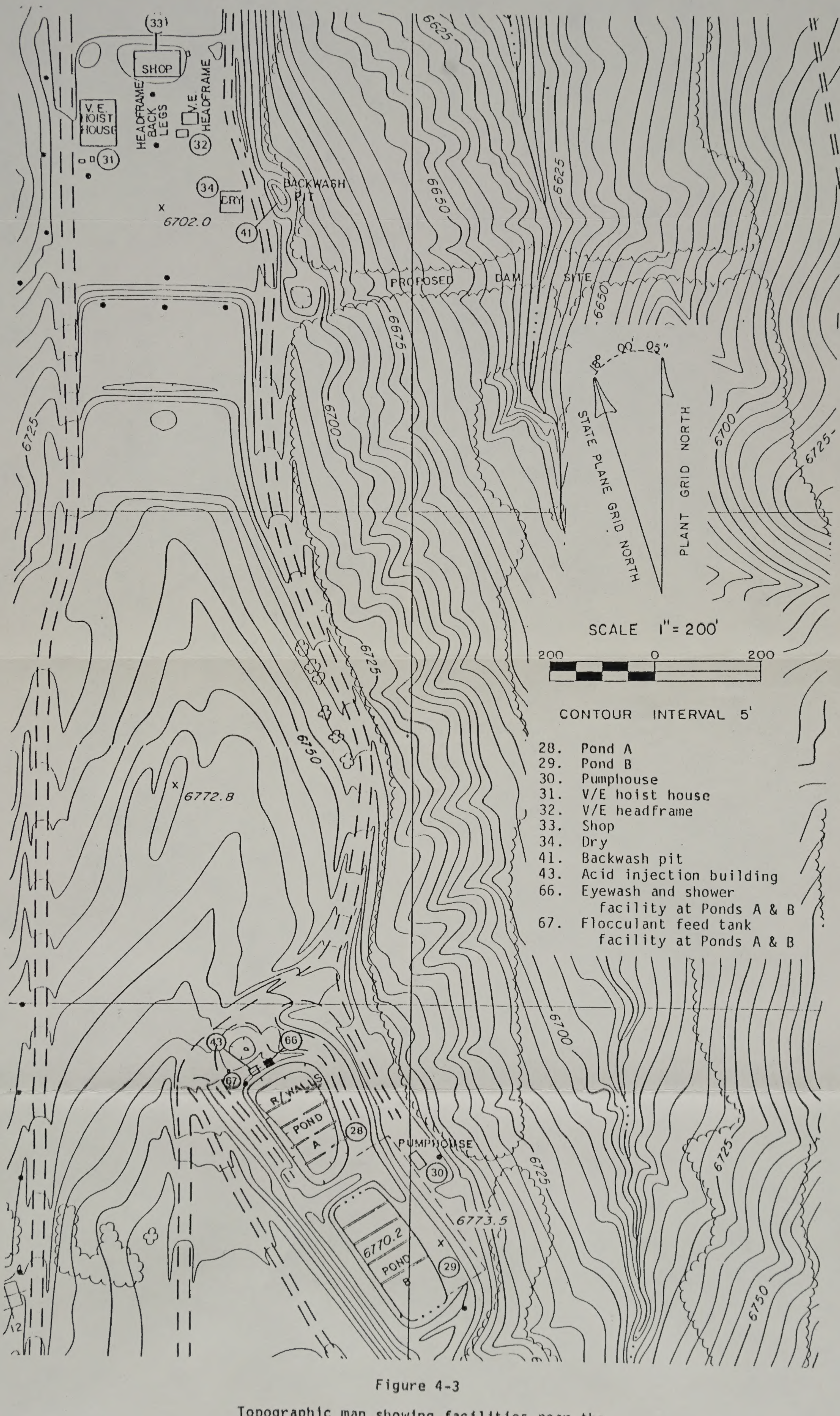
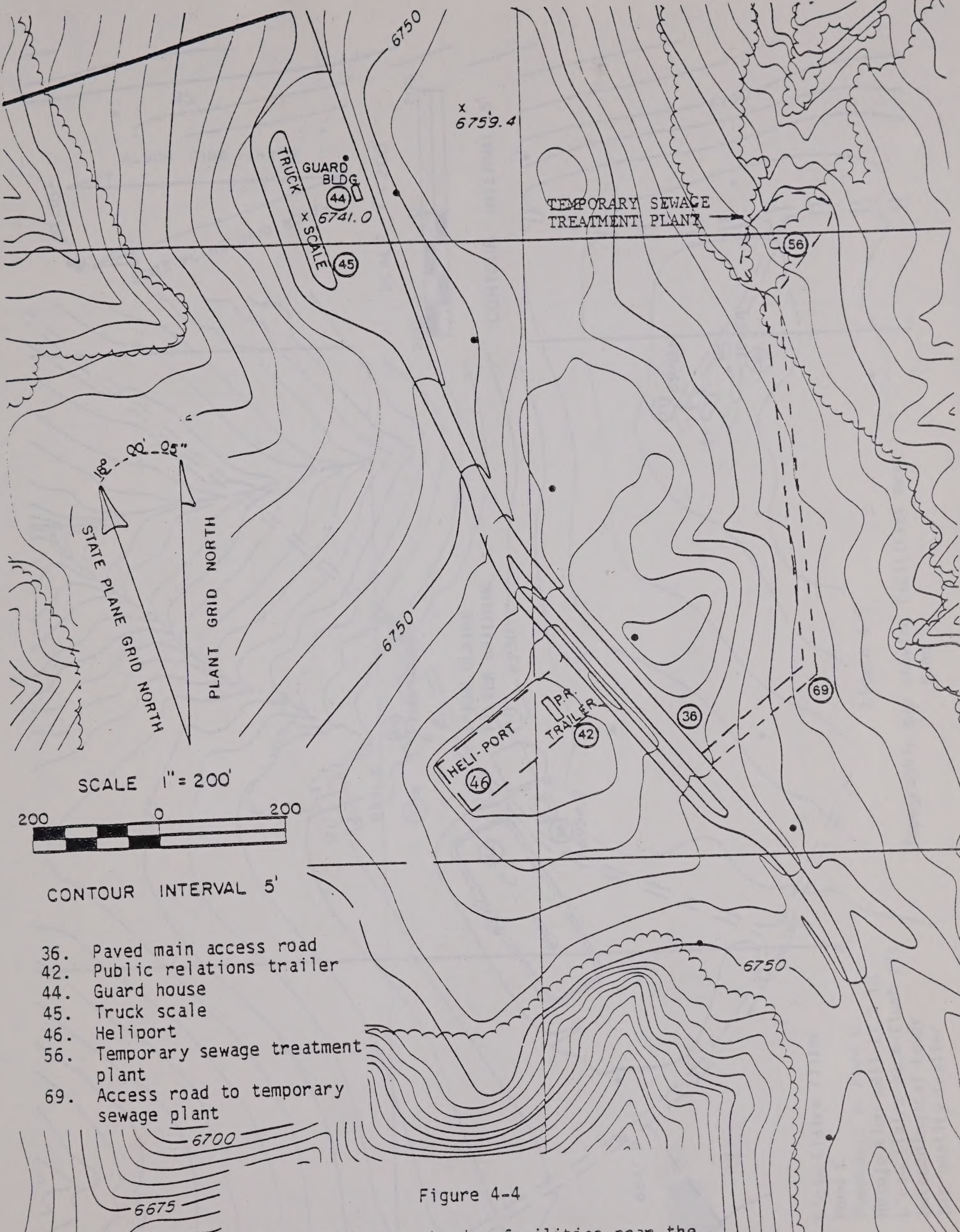


Figure 4-3

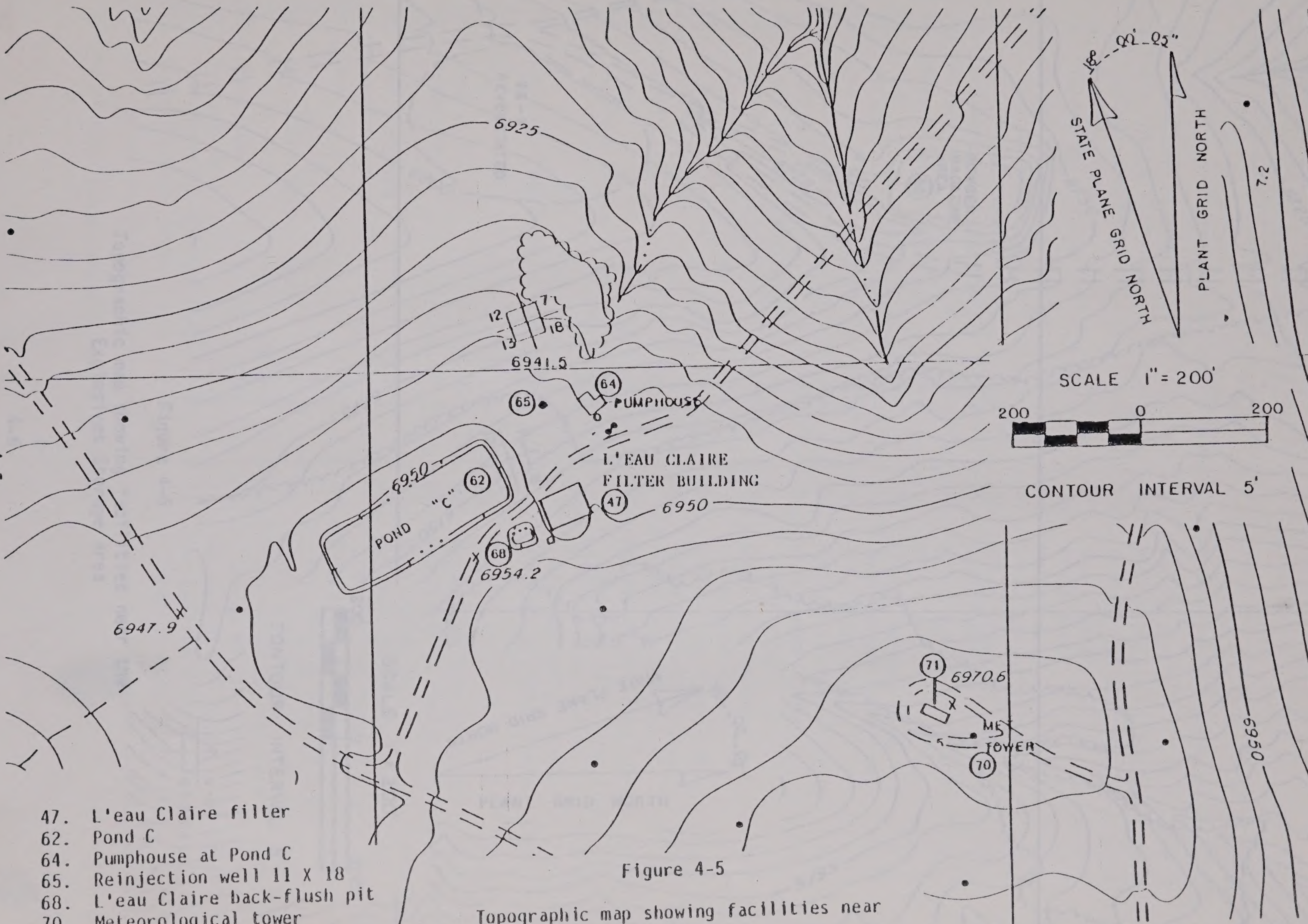
Topographic map showing facilities near the V/E Shaft and Ponds A and B



36. Paved main access road
42. Public relations trailer
44. Guard house
45. Truck scale
46. Heliport
56. Temporary sewage treatment plant
69. Access road to temporary sewage plant

Figure 4-4

Topographic map showing facilities near the Guard Building and Heliport



47. L'eau Claire filter
62. Pond C
64. Pumphouse at Pond C
65. Reinjection well 11 X 18
68. L'eau Claire back-flush pit
70. Meteorological tower
71. Air quality trailer

Figure 4-5

Topographic map showing facilities near Pond C

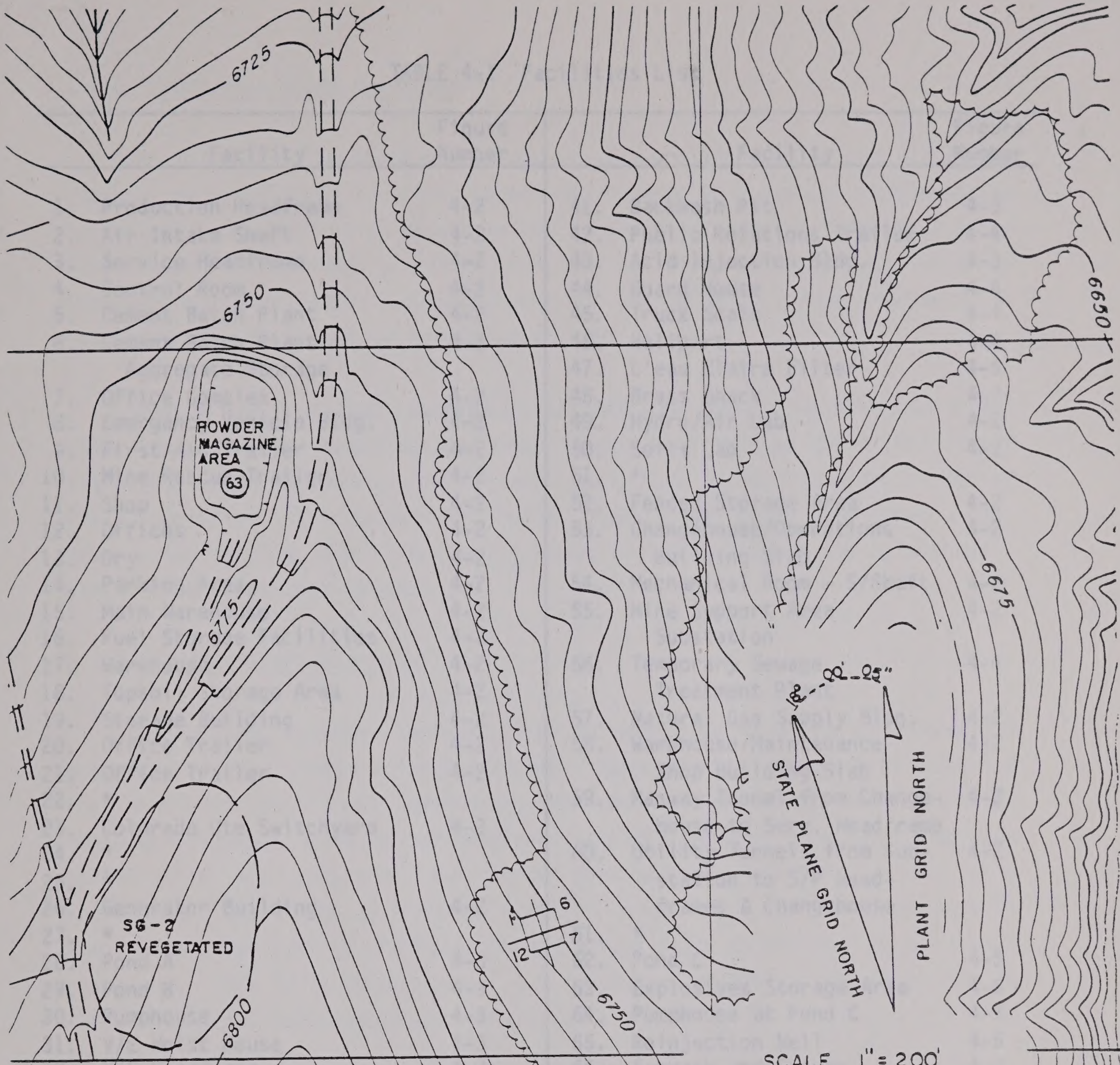


Figure 4-6

Topographic map showing facilities near the Explosives Storage Area

TABLE 4-1 Facilities List

Facility	Figure Number	Facility	Figure Number
1. Production Headframe	4-2	41. Backwash Pit	4-3
2. Air Intake Shaft	4-2	42. Public Relations Trailer	4-4
3. Service Headframe	4-2	43. Acid Injection Bldg.	4-3
4. Control Room	4-2	44. Guard House	4-4
5. Cement Batch Plant	4-2	45. Truck Scale	4-4
6. Cement Batch Plant Aggregate Storage	4-2	46. Heliport	4-4
7. Office Complex	4-2	47. L'eau Claire Filter	4-5
8. Emergency Vehicle Bldg.	4-2	48. Brass Shack	4-2
9. First Aid Trailer	4-2	49. Hydro/Air Lab	4-2
10. Mine Rescue Trailer	4-2	50. Soils Lab	4-2
11. Shop	4-2	51. *	
12. Offices	4-2	52. Fenced Storage Area	4-2
13. Dry	4-2	53. Changehouse/Operations Building Slab	4-2
14. Parking Area	4-2	54. Mechanical Room - S/Shaft	4-2
15. Main Warehouse	4-2	55. Mine Support Area Substation	4-2
16. Fuel Storage Facilities	4-2	56. Temporary Sewage Treatment Plant	4-4
17. Warehouse	4-2	57. Natural Gas Supply Bldg.	4-2
18. Topsoil Storage Area	4-2	58. Warehouse/Maintenance Shop Building Slab	4-2
19. Storage Building	4-2	59. Manway Tunnel from Change-house to Serv. Headframe	4-2
20. Office Trailer	4-2	60. Utility Tunnels from Sub-station to S/P Head-frames & Changehouse	4-2
21. Office Trailer	4-2	61. *	
22. *		62. Pond C	4-5
23. Colorado Ute Switchyard	4-2	63. Explosives Storage Area	4-6
24. *		64. Pumphouse at Pond C	4-5
25. *		65. Reinjection Well	4-5
26. Generator Building	4-2	66. Eyewash and Shower Facility at Ponds A & B	4-3
27. *		67. Flocculant Feed Tank Facility at Ponds A & B	4-3
28. Pond A	4-3	68. L'eau Claire Back-Flush Pit	4-5
29. Pond B	4-3	69. Access Road to Temporary Sewage Plant	4-4
30. Pumphouse	4-3	70. Meteorological Tower	4-5
31. V/E Hoist House	4-3	71. Air Quality Trailer (Station 023)	4-5
32. V/E Headframe	4-3		
33. Shop	4-3		
34. Dry	4-3		
35. Fuel Storage	4-2		
36. Paved Main Access Road	4-2 and 4-4		
37. Generator	4-2		
38. Storage Yard	4-2		
39. Environmental Storage Bldg.	4-2		
40. Shale Disposal Area	4-2		

* Facilities since removed; see Figure 4-2

4.1.2 Production Shaft Headframe

The Production Shaft Headframe houses 2 each 9500 hp hoists which are capable of dumping 52 tons of mined rock every 90 seconds in commercial operations. The Production Headframe was a continuous pour of concrete (called slip forming) completed in 1978. All the hoisting equipment was built by Canadian General Electric. Commissioning of the hoist and other equipment in the Production Headframe was completed in 1983.

Work in the Production Headframe for 1985 was limited to maintenance and minor repairs. Some headframe equipment floors were painted and safety chains installed around equipment. Maintenance work that is performed on a regular basis include: lubrication of hoist ropes, regrooving the drum, non-destructive testing of all the hoist ropes, elevator testing and maintenance, and overhead crane maintenence.

4.1.3 Service Shaft Headframe

The 34-foot diameter Service Shaft is used for hoisting both men and materials and as a ventilation air intake. Construction commenced in 1978 and the headframe shell was completed that year. Following shaft sinking, construction began again in the headframe in 1981. At this time, the headframe installation was completed and three service and materials hoists were installed. One hoist, a 1500-hp friction hoist built by Canadian General Electric and two smaller 300-hp auxiliary hoists built by Bertram Nordberg were installed. The hoist installation and headframe equipping was completed in 1982, with final commissioning of the hoists in 1983.

Maintenance work was the major activity in the Service Headframe in 1985. Non-destructive testing and lubrication of the hoist ropes were carried out on a quarterly basis. Maintenance items on the auxiliary cages and hoists included cleaning the brakes, brake drag test, limit safety switch test, changing rigid guide rollers to pneumatic type, the annual shortening of the hoist ropes, and cage chairing.

Some major construction work in the Service Shaft for 1985 included re-aligning the shaft guide steel for the Main Cage. The 7" x 7" guide steel for the Main Cage was completely re-aligned from the shaft bottom to the collar level to help the Main Cage operate more smoothly up and down the shaft.

Other repair work included replacing corroded steel slings, used to support the electrical power cable in the shaft, with new stainless steel ones.

Also, the Main Cage was structurally reinforced around the crosshead. Additional steel was welded in and the overall reliability of the Main Cage was upgraded.

4.1.4 Ventilation/Escape Hoist and Headframe

Construction of the 15-foot diameter Ventilation/Escape Shaft hoist house, headframe, and surface facilities were started in 1978 and completed in 1979. The hoist house encloses a double-drum hoist built by Nordberg, having dual 1000-hp motors, and all the equipment associated with the hoist. Two surface buildings were constructed to house the shop and dry facilities. This area was used until the end of 1981 when dewatering of the shaft ceased, and it was allowed to flood. Since then only maintenance and cleanup work has been performed.

4.1.5 Electric Power and Switching Facilities

Electrical power for the site is supplied by Colorado-Ute Electric at 138 kV. At the Mine Support Area Substation, the power is transformed down to 13.8 kV and 5 kV for distribution to the facilities around the site. The substation was energized in April of 1982, and at that time the 1000-kW natural-gas-powered generators which had supplied power to the site were shut down. Four of these generators are maintained for emergency power.

4.1.6 Water Wells

Water for site use is hauled via truck from well 24-25 on Piceance Creek during the warmer months. During the winter months, water is supplied from the mine water ponds and clearly-labeled "non-potable". Bottled water is used for drinking purposes.

4.1.7 Office, Warehouse, and Shop Facilities

No new buildings or facilities have been constructed in 1985. Only routine maintenance and minor repairs have been made.

4.1.8 Concrete Batch Plant

A concrete Batch Plant was set up in 1978 during the initial construction of the headframes. This plant supplied concrete for all of the construction on the site. The facility is equipped with cement storage silos, aggregate storage building, boiler building, concrete measuring and mixing facility, and control room. The plant was shut down in 1982 but is being maintained until construction activities are resumed.

4.1.9 Explosives Storage and Use

The explosives storage (powder magazine) area is, as shown on Figure 4-6, remotely located from areas of major activity. The facility continues to be permitted annually through the State of Colorado.

4.1.10 Water Treatment Facilities

There were no changes made to the water treatment facility in 1985.

Pond A was drained and cleaned of built-up sediment which had reduced Pond A by 50% capacity. The wooden baffles were repaired and Pond A was restored to 100% operation. The acid addition system is operated as needed to control the pH.

In 1985, all the mine water (see Table 4-2) was treated by temporary storage in Ponds A and B to settle solids and add acid, if necessary, to reduce pH. Following treatment, mine water was discharged via East No Name Gulch to Piceance Creek under valid NPDES permit. For the years 1981 to 1985, the overall water treatment-and-use summary is:

	(10^6 gallons)				
	1981	1982	1983	1984	1985
Total water pumped from shafts	634	291	231.5	201.5	183.5
Water used, evaporated, etc.	164	30	13.0	24.5	35.9
Water treated					
NPDES surface discharge	331	134	218.5	177	147.6
Reinjected	99	127	0	0	0
Sprinkler irrigated	40	0	0	0	0
Total treated	470	261	218.5	177	147.6

Further water management aspects are discussed in Section 7.2.

4.1.11 Hydrology Laboratory

This lab is equipped with all the necessary laboratory and safety equipment and supplies to ensure the proper preparation and testing of field water samples: pH, temperature, conductivity, and fluoride. Samples for additional water quality parameter determination are labeled, preserved, and sent to a commercial laboratory. This program includes blank, split (to a second laboratory), and spiked samples, as necessary, for the CB quality assurance program.

4.1.12 Permanent Mine Support Buildings

Construction of additional permanent Mine Support Buildings was suspended in 1982. Maintenance work on the existing facilities is the only work activity since that time.

Table 4-2

1985 Water Usage

USE SOURCE	ALL SHAFTS: GLAND WATER PUMP STATION 10**6 GAL	 TOTAL 10**6 GAL	OFF-TRACT WATER USE TWN RIFLE 10**6 GAL	 TOTAL 10**6 GAL	TRACT WATER USE: BATCH P 24X-25 10**6 GAL	CONSTR PONDS 10**6 GAL	CONSTR 24X-25 10**6 GAL	DUST CONT PONDS 10**6 GAL	EVP & LEAK POND C 10**6 GAL	NPDES REL PONDS 10**6 GAL	REINJECT PONDS 10**6 GAL	SPR IRRIG POND C 10**6 GAL	 TOTAL 10**6 GAL
JANUARY	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	12.42	0.00	0.00	12.43
FEBRUARY	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	11.84	0.00	0.00	11.85
MARCH	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	13.12	0.00	0.00	13.13
APRIL	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	12.44	0.00	0.00	12.45
MAY	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00	13.99	0.00	0.00	14.04
JUNE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	12.68	0.00	0.00	12.70
JULY	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	12.31	0.00	0.00	12.32
AUGUST	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	11.64	0.00	0.00	11.65
SEPTEMBER	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	11.45	0.00	0.00	11.47
OCTOBER	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	12.19	0.00	0.00	12.19
NOVEMBER	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	11.58	0.00	0.00	11.59
DECEMBER	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	11.74	0.00	0.00	11.75
TOTAL YTD	0.00	0.00	0.00	0.00	0.00	0.05	0.07	0.04	0.00	147.41	0.00	0.00	147.56
TOTAL YRS	190.60	190.60	1.30	1.30	2.40	18.15	1.87	6.74	144.80	1,332.51	225.70	79.00	1,811.16

USE SOURCE	ALL SHAFTS: GLAND WATER PUMP STATION AC FT	 TOTAL AC FT	OFF-TRACT WATER USE TWN RIFLE AC FT	 TOTAL AC FT	TRACT WATER USE: BATCH P 24X-25 AC FT	CONSTR PONDS AC FT	CONSTR 24X-25 AC FT	DUST CONT PONDS AC FT	EVP & LEAK POND C AC FT	NPDES REL PONDS AC FT	REINJECT PONDS AC FT	SPR IRRIG POND C AC FT	 TOTAL AC FT
JANUARY	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	38.11	0.00	0.00	38.14
FEBRUARY	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	36.33	0.00	0.00	36.36
MARCH	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	40.26	0.00	0.00	40.29
APRIL	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	38.19	0.00	0.00	38.21
MAY	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.05	0.00	42.92	0.00	0.00	43.07
JUNE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	38.90	0.00	0.00	38.96
JULY	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	37.78	0.00	0.00	37.81
AUGUST	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	35.72	0.00	0.00	35.74
SEPTEMBER	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	35.15	0.00	0.00	35.19
OCTOBER	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	37.40	0.00	0.00	37.42
NOVEMBER	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	35.55	0.00	0.00	35.57
DECEMBER	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	36.02	0.00	0.00	36.05
TOTAL YTD	0.00	0.00	0.00	0.00	0.00	0.15	0.22	0.11	0.00	452.33	0.00	0.00	452.80
TOTAL YRS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.2-A

1985 Water Usage (Continued)

				WATER PUMPED					
POND A	POND B	POND C	TOTAL	33X-1	24X-25	32X-12	V/E SHAFT	PROD & SERV	TOTAL
10**6 GAL	10**6 GAL	10**6 GAL	10**6 GAL	10**6 GAL	10**6 GAL	10**6 GAL	10**6 GAL	10**6 GAL	10**6 GAL
1.50	0.70	0.00	2.20	0.00	0.00	0.00	0.00	16.14	16.14
1.50	0.70	0.00	2.20	0.00	0.00	0.00	0.00	14.10	14.10
1.50	0.70	0.00	2.20	0.00	0.00	0.00	0.00	15.63	15.63
1.50	0.70	0.00	2.20	0.00	0.01	0.00	0.00	14.88	14.88
0.00	0.70	0.00	0.70	0.00	0.05	0.00	0.00	15.76	15.81
0.00	0.70	0.00	0.70	0.00	0.02	0.00	0.00	15.38	15.40
1.50	0.12	0.00	1.62	0.00	0.01	0.00	0.00	15.68	15.69
1.50	0.70	0.00	2.20	0.00	0.01	0.00	0.00	15.49	15.50
1.50	0.70	0.00	2.20	0.00	0.01	0.00	0.00	15.29	15.31
1.50	0.70	0.00	2.20	0.00	0.00	0.00	0.00	15.27	15.27
1.50	1.50	0.00	3.00	0.00	0.00	0.00	0.00	14.47	14.47
1.50	1.50	0.00	3.00	0.00	0.00	0.00	0.00	15.27	15.27
				0.00	0.11	0.00	0.00	183.36	183.46
				4.30	8.21	5.90	678.90	1,429.26	2,120.66

				WATER PUMPED					
POND A	POND B	POND C	TOTAL	33X-1	24X-25	32X-12	V/E SHAFT	PROD & SERV	TOTAL
AC FT	AC FT	AC FT	AC FT	AC FT	AC FT	AC FT	AC FT	AC FT	AC FT
4.60	2.15	0.00	6.75	0.00	0.00	0.00	0.00	49.52	49.52
4.60	2.15	0.00	6.75	0.00	0.00	0.00	0.00	43.27	43.27
4.60	2.15	0.00	6.75	0.00	0.00	0.00	0.00	47.95	47.95
4.60	2.15	0.00	6.75	0.00	0.02	0.00	0.00	45.64	45.67
0.00	2.15	0.00	2.15	0.00	0.15	0.00	0.00	48.36	48.51
0.00	2.15	0.00	2.15	0.00	0.06	0.00	0.00	47.20	47.26
4.60	0.37	0.00	4.97	0.00	0.03	0.00	0.00	48.12	48.15
4.60	2.15	0.00	6.75	0.00	0.02	0.00	0.00	47.53	47.55
4.60	2.15	0.00	6.75	0.00	0.04	0.00	0.00	46.93	46.97
4.60	2.15	0.00	6.75	0.00	0.00	0.00	0.00	46.85	46.85
4.60	4.60	0.00	9.21	0.00	0.00	0.00	0.00	44.41	44.41
4.60	4.60	0.00	9.21	0.00	0.00	0.00	0.00	46.85	46.85
				0.00	0.33	0.00	0.00	562.63	562.96
				0.00	0.00	0.00	0.00	0.00	0.00

4.1.13 Off-Tract Engineering Studies

Union Oil Company of California

No additional tests were conducted with Union's pilot retort in 1985.

Stearns-Catalytic Corporation

Stearns-Catalytic Corporation, Denver, completed engineering services in the area of Surface Materials Handling and Aboveground Retorting Facilities.

In-Situ, Inc.

In-Situ, Inc., a Denver based geotechnical consultant, completed physical characterization of the spent shale, derived from the AGR test runs carried out on the C-b Tract shale in Union's pilot plant in 1984, and established an overall spent shale disposal plan for the CB Project. A plan jointly developed by In-Situ and Stearns-Catalytic, scheduled for submittal to the Colorado Mined Land Reclamation Board, was postponed.

In addition, raw shale moisture tests on the run-of-mine and AGR feed material were completed to confirm design basis.

Fluor Engineers, Inc.

Fluor Engineers, Inc. of Irvine, California, provided engineering design assistance.

Analytical Laboratories

Accu-Labs Research, Inc. of Wheat Ridge, Colorado, and Bookcliff Laboratory Division (ACZ, Inc.) of Steamboat Springs, Colorado, were retained to analyze water samples.

4.2 Off-Tract Facilities and Description

4.2.1 Grand Junction Office

No change in 1985.

4.2.2 Grand Junction Laboratory

This laboratory, which is located approximately 4 miles west of the Grand Junction Horizon Court office was closed in November 1984. Essential equipment was relocated to the C-b site for use in field analysis. All other analytical work is performed by contract laboratories.

4.2.3 Rifle Warehouse and Rail Siding

No change in 1985.

4.2.4 Rifle Parking Lot

No change in 1985.

4.2.5 Utility Cooridors

No change in 1985.

4.3 Access/Service/Support Activities

4.3.1 Fuel Storage and Dispensing

The Fuel Dispensing Facility, which is computer controlled, was put into service in 1981. It is designated as Facility #16 on Figure 4-2. Gasoline, as well as diesel fuel, are piped into the dispensing system. Liquid petroleum gas storage tanks are also located around the site to provide gas for heating the site's buildings and facilities. Natural gas service to the site was expanded in 1984 and now supplies the generator building, shop building, and the mine air heaters. Fuel consumption during the year was 2687 gallons of diesel, 12,975 gallons of gasoline, 22,277 gallons of LPG and 10,081 thousand cubic feet of natural gas. Consumables usage is summarized for 1985 in Table 4.3.

TABLE 4-3

1985 CB CONSUMABLES USAGE

USE	WTR TREATMENT ACID PONDS A & B	DIESEL FUEL #1	DIESEL FUEL #2	GASOLINE	PROPANE	NATURAL GAS	DUST PALLITATIVE	MINED SHALE	MINED SHAFT ROCK	EXPLOSIVES	EXPLOSIVES FREQUENCY	DISTURBED ACREAGE	FLOCCULANT
UNITS	10**3 GAL	10**3 GAL	10**3 GAL	10**3 GAL	10**3 GAL	10**3 MCF	10**3 GAL	10**3 CU	10**3 CU YD	10**3 LBS	10**3	ACRES	10**3 GAL
JANUARY	0.000	0.000	0.034	1.281	4.707	2.361	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FEBRUARY	0.000	0.000	0.054	0.978	2.450	2.643	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MARCH	0.000	0.000	0.091	1.148	2.305	1.230	0.000	0.000	0.000	0.000	0.000	0.000	0.000
APRIL	0.000	0.000	0.165	1.102	2.075	0.988	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MAY	0.000	0.000	0.187	0.932	0.000	0.205	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUNE	0.188	0.000	0.831	0.940	0.000	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JULY	0.258	0.000	0.434	1.207	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUGUST	0.000	0.000	0.318	0.999	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEPTEMBER	0.164	0.000	0.441	1.151	2.290	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OCTOBER	0.250	0.000	0.000	1.099	1.500	0.176	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NOVEMBER	0.133	0.000	0.079	1.069	4.485	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DECEMBER	0.055	0.000	0.053	1.071	2.465	2.396	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL YTD	1.048	0.000	2.687	12.977	22.277	10.081	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL YRS	117	69	455	322	614	797	33	116	11	332	2	191	2

4.3.2 Stamler Feeder Breaker

The Stamler feeder breaker (a rock crusher) was rented to Widco in Washington State for 3 months.

After return to C-b site, the Stamler was reconditioned, including sandblasting and painting.

4.3.3 Surface Mobile Equipment

A fleet of mobile surface maintenance equipment is maintained to service the needs around the site. This work includes loading and unloading supplies, road maintenance and repair, pond construction and repair, construction of erosion control structures, and snow removal in winter.

A commercial-size twin boom Tamrock jumbo drill rig was delivered and stored at C-b site. Also, modification work by EIMCO on the 918 LHD's was started to make them permissible as per MSHA standards.

4.3.4 Communications

Repairs and maintenance work was done on an as-needed basis on the mine phone communications system. Paging telephones were installed at each station in the Service Shaft, Control Room, Mine Shop, elevators in the Service and Production Headframes, Mine Rescue Trailer, and Mine Support Area Substation.

4.3.5 Other Service and Support Activities

Other service and support activities relate to:

(1) roads and guard rails;
(2) truck weighing facility;
(3) sewage treatment facility;
(4) pump gland seal water system;
(5) fire water system;
(6) helicopter pad; and
(7) aerial survey.

No additional work was performed on these areas during 1985.

4.4 Mining

4.4.1 Production, Service, and Ventilation/Escape Shafts

During 1985, work in the Production and Service Shafts was limited mainly to maintenance and minor repairs. Wooden guides in the Service Shaft were constantly checked for tightness and alignment and periodically linseed oil was applied to the upper dry guides. Water rings were cleaned. Shaft inspections were conducted weekly. No maintenance work was performed in the V/E Shaft.

4.4.2 Production/Service Shaft Pumping System

During 1985, as well as in previous years, a large portion of the maintenance work was performed on U/G pumps and pumping systems; such as piping, valves, hoses, electric starters, controls, floats, ditches, sumps, etc.

In 1985, a complete modification of the Production Shaft sump pumping system was completed. Two new 4" pipelines were installed from the lower void level to the shaft bottom. A new pump platform was built and installed in the shaft bottom. All new electric starters and controls were installed. All the old pump hoses and temporary pumping system was removed. Overall, the Production Shaft sump pumping system is more efficient and a safer operation to maintain.

4.4.3 Mine Ventilation

Main mine ventilation is provided by a 75-hp fan on the surface, equipped with a heter, pushing fresh air down the Service Shaft and exhausting the air up the Production Shaft. Ventilation is controlled on the levels by means of airlock doors and regulators to give the required ventilation across each level. The Production and Service Shaft bottoms are ventilated by twin 50 HP fans located on the lower level. A ventilation schematic showing airflow quantities and directions appeared in the 1981 CB Annual Report on Figure 4-38.

Work that was done on the ventilation system in 1985 included: routine maintenance, minor repairs, and correcting some MSHA permissible tags.

Routine maintenance and calibration of the mine monitoring system and sensors continued in 1985. This system was completed in 1983 and is equipped with 26 sampling points to continuously monitor methane gas concentration in the mine atmosphere (Table 4-4) and another 46 points to monitor functions such as air flow, fan operation, pump operation, and water levels.

TABLE 4-4 Methane Monitoring Locations

Level	Location
Surface	Mine Air Exhaust at the Production Shaft
Midshaft	Electrical Vault
Midshaft	Sump
Midshaft	Main Drift at the Production Shaft
Midshaft	East Rope Drift at the Production Shaft
Midshaft	West Rope Drift at the Production Shaft
Air	Drift West of Service Shaft
Air	Ore Pass Drift
Air	Main Drift at the Production Shaft
Upper Void	Drift West of Service Shaft
Upper Void	Ore Pass Drift
Upper Void	Sump
Upper Void	Main Drift at the Production Shaft
Upper Void	Mining Sample Drift
Intermediate Void	Drift West of Service Shaft
Intermediate Void	Ore Pass Drift
Intermediate Void	Main Drift at the Production Shaft
Lower Void	Electrical Vault
Lower Void	Sump
Lower Void	Main Drift at the Production Shaft
Lower Void	Service Shaft Ventilation Tubing
Lower Void	Northeast Conveyor Drift
Lower Void	Northwest Conveyor Drift
Lower Void	Southeast Conveyor Drift
Lower Void	Southwest Conveyor Drift
Lower Void	Drift South of Production Shaft

5.0 PROCESSING

No shale oil processing facilities exist on the C-b Tract. Engineering studies related to processing are discussed in Section 4.1.13.

6.0 LAND DISTURBANCE AND RECLAMATION

No major reclamation activities were performed during the 1985 reporting period. Other than the evaluation of the processed shale reclamation demonstration plots and topsoil stockpiles, the only activity was erosion control oriented. This project involved splitting the diversion channel entering sediment basin #1B and diverting a large portion of this stream into basin 7A, which was enlarged significantly enough to handle the increased runoff. Another erosion control project involved the construction of a settling basin up-stream from the culvert, which carries runoff under the road near Pond A & B, and into basin #5. This project was necessary because during intense thunder storms large rocks would be carried with the runoff to the inlet of the culvert, where they would lodge, and block the free flow of runoff through the culvert. The runoff would then cross and run down the road to basin #2, sometimes causing damage to the road. The settling pond allows the rocks to be deposited prior to reaching the culvert, thus allowing runoff to pass through the culvert and into basin #5, as originally designed.

6.1 Disturbed and Reclaimed Areas

No new areas of disturbance or reclamation occurred during the reporting period. Therefore, the areas of disturbance, as listed in Table 6-1, are unchanged since last year's report. The 1985 acreage revegetated was reduced to zero from 3 acres in 1984.

6.2 Stockpile and Disposal Activities

No mining activities occurred during 1985 and therefore, no stockpiling and/or disposal. Tonnages remain the same as 1984.

6.3 Disturbance/Reclamation Status

The status of areas in graded condition, topsoil stockpiles, and revegetation are all unchanged since the 1984 Annual Report.

TABLE 6-1

Estimates of Acreages Disturbed and Revegetated

Area[1]	Acreages Disturbed Before 1985	Acreages Disturbed During 1985	Acreages Revegetated Before 1985	Acreages Revegetated During 1985
1) Guard House & Truck Scale Area	2			
2) Sewage Treatment Plant & Road	2			
3) Heliport & P.R. Trailer	1			
4) Main Access Road	24			
5) V/E Shaft Area	14			
6) Proposed Dam Site (Little Gardenhire)	3		3	
7) Fill Material Area	12			
8) Explosives Storage	2			
9) Mine Support	73			
10) Raw Shale Embank.	12		1	
11) Rock Stockpiles	4			
12) Topsoil Stockpiles	13		11	
13) Water Discharge & Application Area	4			
14) Abandoned Access Road	10		10	
15) Permitted Areas				
16) Irrigation Pipeline	4		4	
17) Pond "C" Pipeline	2		2	
18) Drill Pads & Roads	6	0	7	
19) Raw Shale Demonstration Plot				
20) Processed Shale Demonstration Plot				
TOTALS	191	0	38	0

[1]Numerated Areas in column correspond to numerated areas on "C-b Tract Map" #AD-0039, Rev. 4, 1984, Figure 6-1 (jacket map).

6.4 Reclamation Management

The processed shale reclamation demonstration plots (both the 1983 Plot and 1984 Plot) were fertilized and irrigated during the 1985 growing season.

A small scale (200 transplants) shrub transplant study was initiated in 1985. This study involved spraying strips of existing vegetation with herbicide to reduce competition and then planting shrub seedlings within the strips. This study is a joint effort between CB personnel and OSPO staff. The results of the first year are inconclusive as regards survival rates (nearly all seedlings survived). However, it was noted that transplants in the sprayed strips had much more vigorous growth than transplants planted directly into existing vegetation.

The raw and processed shale plots and topsoil stockpiles were sampled and evaluated for cover, production, and species composition. Data from this sampling are presented in the January, 1986 Data Report, and analysis of the data is discussed in Section 9.3.10 of this report.

6.4.1 Associated Costs

The associated cost for reclamation during 1985 was for labor involved in sampling and analysis. The approximate cost was $2500.

7.0 ENVIRONMENTAL PROTECTION AND CONTROL

7.1 Air Pollution Control and Visibility

Principal activities in 1985 with the potential to effect air quality included vehicle transport along access and haul roads, and infrequent but permitted open burning.

Comparisons of air monitoring measurements with ambient air quality standards are made in Table 7-1; compliance with these standards was achieved in all cases except Ozone which had five instances with levels greater than 235 ug/m^3.

Air pollution permit conditions require use of control equipment and specified operating procedures. Permit status is summarized in Section 7.11 in tabular form showing permit purpose, agency, permit number and approval date. CB is in compliance with all air permits.

CB holds a Prevention-of-Significant-Deterioration (PSD) Permit for the Ancillary Phase of MIS operations (defined in 1977 as up to 5,000 barrels/day nominally) from the EPA (Merson, 1977). Approval of an amendment to incorporate aboveground retorting and oil upgrading for a total capacity of 13,500 bbls/calendar day was received from the EPA in September, 1983 (Duprey, 1983). A draft amendment to the 1983 permit to update MIS operations, emissions and control systems was required prior to May 15, 1986.

The CB project obtained a Fugitive Dust Permit (C-11,454) from the Colorado Air Pollution Control Division in 1977, revised in 1980. Pursuant to this permit, CB paved the major access road to the Tract. This work was completed in August of 1978. PSD and Fugitive Dust Permits require dust control on haul roads by regular applications of water and dust palliatives. Water has been applied to the haul roads on an as-needed basis; dust palliatives have been applied as needed.

In 1981, a permit was issued by the State of Colorado for a feeder-breaker to crush oil shale rock to minus 8-inch size. Maximum throughput is limited to less than 1,000 tons per hour and annual throughput is limited to 70,000 tons.

Table 7-1

Comparisons of Maximum Background Levels with National Ambient Air Quality Standards (Station AB23)

Time Period	Constituent	Standard Limit Primary	Secondary	Baseline Period 11/74-10/76	1977	1978	1979	1980	1981	1982	1983	1984
	Averages (ug/m^3)											
Annual	SO_2	80.0		1.0[a]	0.3	1.3	0.4	1.0	1.5	1.4	1.8	1.0
	NO_2			1.5[a]	0.9	0.0	2.0	1.0	10.3[b]	2.7	1.3	3.6
	Particulates[c]	75.0	60.0	11.2[a]	6.7	9.1	13.3	7.0	10.2	7.5	6.5	4.6
	Max. Concentration (ug/m^3)											
1-hour	CO	40,000.0		3539.0	1530.8	4200.0	2900.0	3800.0	1800.0	600.0	140.0	140.0
	Oxidant (O_3)	235.[d]		152.	164.	161.	246.[e]	154.	155.	143.	135.	135.
3-hour	SO_2		1300.0	88.0	17.6	24.0	16.4	13.1	18.3	15.7	13.9	12.2
8-hour	CO	10,000.0		2894.0	816.8	4000.0	1700.0	3000.0	1800.0	200.0	115.0	50.0
24-hour	SO_2	365.0		43.0	11.5	15.0	7.6	11.9	17.3	13.0	10.7	10.7
	Particulates	260.0	150.0	171.0	74.0	64.1	99.8	58.4	86.2	51.4	46.9	28.5

[a] Highest annual average during baseline period.
[b] <50% data.
[c] Geometric mean.
[d] Standard is exceeded if the number of exceedances of hourly values is $\geq$ 3 in a 3-year period.
[e] Only 1 value >235 to date.

Water spray bars are utilized as the approved emission control devices. No PSD permit was necessary from the EPA since the annual emission level does not exceed the de minimis level of 25 tons of dust per year (based on an emission factor of 0.1 lb. of dust per ton of rock); emissions from this operation will be included in the next PSD permit amendment. The feeder-breaker was last used on-tract in 1984.

With regard to visibility protection, no specific visibility-related regulations have been promulgated by the EPA although a task force has been established by EPA to develop a long-term strategy for dealing with visibility impairment. Visibility monitoring has been conducted since 1975, under request of the OSPO. No significant degradation in visual range has been noted since the inception of this program. Mean visual range remains in the neighborhood of 80 miles.

7.2 Water Management and Augmentation

The physical description of the water treatment facilities is given in Section 4.1.10. In 1985 discharge into Piceance Creek from Ponds A and B via East No Name Gulch under NPDES permit was the only part of the facilities utilized.

Table 4-2 summarizes water usage by month; annual and cummulative annual values are also shown. Water treatment rates (gpm) are further summarized on Table 7-2A.

Regarding compliance with the NPDES permit criteria, effluent limitations under the permit (Colorado Department of Health, 1983/1984) are shown on Table 7-3. The Colorado Water Quality Control Commission did not specify a permit limitation for fluoride in the new permit (as required under the previous permit) since they did not judge it necessary to protect stream uses or stream standards for fluoride. In 1985, excursions under the permit were reported to the State as follows:

TABLE 7-2A
Summary of Water Pumped and Used (gpm)

Year	Month	Water Pumped From Mine	Water Used, Stored, Evaporated	Water Treated[1]			
				NPDES Discharges	Sprinkler (Land Application)	Reinjection	Total
1982	Janaury	664	181	-	-	483	483
1982	February	651	154	5	-	492	497
1982	March	535	90	-	-	445	445
1982	April	476	60	-	-	416	416
1982	May	663	87	-	-	576	576
1982	June	588	83	-	-	505	505
1982	July	560	20	540	-	-	540
1982	August	562	22	540	-	-	540
1982	September	532	7	525	-	-	525
1982	October	472	0	472	-	-	472
1982	November	460	2	458	-	-	458
1982	December	495	0	495	-	-	495
1983	January	475	8	467	-	-	467
1983	February	462	11	451	-	-	451
1983	March	467	9	458	-	-	458
1983	April	461	11	450	-	-	450
1983	May	448	1	447	-	-	447
1983	June	442	13	429	-	-	429
1983	July	442	45	397	-	-	397
1983	August	423	39	384	-	-	384
1983	September	421	41	380	-	-	380
1983	October	423	42	381	-	-	381
1983	November	416	19	397	-	-	397
1983	December	405	31	374	-	-	374
1984	January	401	21	380	-	-	380
1984	February	410	26	384	-	-	384
1984	March	392	25	367	-	-	367
1984	April	389	30	359	-	-	359
1984	May	379	26	353	-	-	353
1984	June	390	40	350	-	-	350
1984	July	387	66	321	-	-	321
1984	August	385	76	309	-	-	309
1984	September	378	59	319	-	-	319
1984	October	369	74	295	-	-	295
1984	November	361	58	303	-	-	303
1984	December	359	56	303	-	-	303
1985	January	361	83	278	-	-	278
1985	February	350	56	294	-	-	294
1985	March	350	56	294	-	-	294
1985	April	344	56	288	-	-	288
1985	May	353	40	313	-	-	313
1985	June	356	63	293	-	-	293
1985	July	351	75	276	-	-	276
1985	August	347	86	261	-	-	261
1985	September	343	78	265	-	-	265
1985	October	342	69	273	-	-	273
1985	November	335	67	268	-	-	268
1985	December	324	61	263	-	-	263

(1) Water Pumped = Water Used + Water Treated

TABLE 7-3

Effluent Limitations for the 1983 NPDES Permit

(Outfall 002, Ponds A or B)

Effluent Parameter	Maximum Concentration (mg/l)	
	30-day Average	Daily Maximum
Total suspended solids	30	45
Total dissolved solids	1,700	2,500
Total boron	2.0	3.0
Total ammonia as nitrogen	2.4	N/A(2)
Total iron	11.0	22.0
Total cadmium	0.05	0.10
Total copper	0.04	0.08
Total mercury	0.00005	0.0001
Total silver	0.00053	0.0011

Oil and grease shall not exceed 10 mg/l in any grab sample nor shall there be a visible sheen. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units. There shall be no discharge of floating solids or visible foam in other than trace amounts.

(2) Weekly max 3.6

Table 7-2B

1985 NPDES Permit Excursions

Date	Parameter	Apparent Exeedance Initial Reading	Corrrected Analysis	Excursions
3-20	Mercury (TR)	0.0002 mg/l	< 0.0002 mg/l	0
4-03	Silver (TR	0.006 mg/l	< 0.005 mg/l	0
4-10	Silver (T)	0.014 mg/l	< 0.005 mg/l	0
6-05	Silver (TR)	0.005 mg/l	< 0.005 mg/l	0
6-26	Mercury (TR)	0.0005 mg/l	< 0.0002 mg/l	0
7-24	Mercury (TR)	0.0002 mg/l	< 0.0002 mg/l	0
7-24	pH	9.2	None	1
8-07	Mercury (TR)	0.0002 mg/l	< 0.0002 mg/l	0
9-18	Silver (TR)	0.006 mg/l	< 0.005 mg/l	0
			Total	1

Of these nine possible excursions, only one was still high after resampling and reanalysis. The one that was still high was possibly due to mucking activities n Ponds A and B. Machinery was being used to clean sediment out of the two water storage ponds and thus disrupted the normal water handling and storage scheme.

In 1983 the Colorado Water Control Commission classified Piceance Creek and adopted stream standards for its various reaches (Stewart, 1983). The reach of Piceance Creek near the C-b tract (between Stewart Gulch on the east and Hunter Creek on the west) has been classified: Class II, Aquatic Life, Warm Water and Class II, Recreational and Agricultural. Comparison of Piceance Creek water quality with these stream standards is shown in Table 7-4.

Work was completed in February 1985 on the groundwater flow modeling project initiated in 1984 to partially fulfill CB's Water Augmentation Plan requirements. Results of modeling runs were presented to the State Water Engineer in April 1985 to show projected effects of dewatering at C-b Tract from 1979-1989 on the base flow of Piceance Creek. Again, as was the case in

TABLE 7-4

Comparison of Piceance Creek Water Quality with Stream Standards (mg/l)

Parameter	Stream Standard (a)	Highest 1985 Value October 1984 - September 1985) Station 6007 (Upstream of Tract)	Station 6061 (Downstream of Tract)
Ammonia (Un-ionized)	0.1	0.1	0.14
Boron	4.0	0.17	0.16
Cadmium	0.05	0.002	<0.001
Chlorine (residual)	0.003	(b)	(b)
Chromium (tot)	0.1	(b)	(b)
Chromium (hex)	0.025	(b)	(b)
Coliforms, Fecal	2000/100 ml	No value	No value
Copper	0.04	0.008	0.003
Cyanide	0.005	-0.01	-0.01
Dissolved Oxygen	$\geq$5.0	88.0(d)	11.2
Iron (tot)	11.0	(b)	(b)
Lead	0.10	0.003	-0.001
Manganese	1.0	(b)	(b)
Mercury	0.00005	<0.0001	<0.0001
Nickel	0.2	(b)	(b)
Nitrite	0.5	No value	No value
pH (non-dimen)	6.5 - 9.0	8.6	8.5
Selenium	0.05	0.006	0.003
Silver	0.00053	(b)	(b)
Sulfide, Hydrogen	0.002	(b)	(b)
Zinc	0.6	0.01	0.008

(a) Stream Reach: Piceance Creek between Stewart and Hunter Creeks in zone containing outfall CB 002 from East No Name Gulch; from Stewart (1983).

(b) Not required under CB monitoring program.

(c) Results based on colony count outside the acceptable range (non-ideal colony count).

(d) Value reported in Watstor (3-17-86) for September 4, 1985; probably reflects a misplaced decimal, e.g., 8.8 mg/l.

1984, no depletion in the base flow of Piceance Creek can yet be observed. This will remain the case with the small amount of pumping now being done at CB. Even at a modest development scenario, no effects were observed through 1989.

7.3 Oil and Hazardous Substances and Associated Spill Contingency

The Spill-Prevention Control and Countermeasure Plan includes a description of the potential for accidental spills or release of oil as a result of the Lessee's development of the Tract and associated off-Tract pipelines and terminals. This plan summarizes the potential sources of accidental spills, reviews the current regulations and standards that would apply to the Lessee's activities, and presents the Lessee's Spill-Prevention Control and Contingency Plans for the plant and associated pipelines. A more detailed plan will be developed prior to production of commercial quantities of shale oil and possible hazardous wastes.

For spills of toxic or hazardous material, temporary containment materials have been purchased to build dams and barriers. Clean-up and containment kits are stored in the Emergency Vehicle Building. Instructions were available to employees in each shift crew.

7.3.1 Summary of Potential and Actual Spills During Construction

During on-going activities, spills of diesel fuels and other fuels and lubricants are possible during transportation, loading, and unloading operations. Dust suppressants and smaller amounts of miscellaneous chemicals used during on-going activities also pose pollution threats if quantities of these materials reach drainages or flowing streams near the Tract. The trucking, loading, and unloading of fuels and chemicals during construction is a potential source of accidental spills. A program has been implemented to ensure that future transformers brought on Tract will not contain PCB's.

There were no reportable spills (see 7.3.3) requiring activities of the Spill Contingency Plan during the year.

7.3.2 Oil and Hazardous Substance Inventory

A list of oil and hazardous substances presently on-Tract is given on Table 7-5. The list identifies those both on- and off-Tract which would be classified as wastes if allowed to escape; locations are cross-referenced to maps in this report. Storage is consistent with Lease requirements.

7.3.3 Notification Under the Response Plan

In the event of an accidental spill of oil or hazardous substance in quantities greater than those specified by the regulations, various governmental entities must be notified. Spills consisting solely of oil are reportable when they reach or have the potential of reaching a waterway in quantities which cause a film, sheen or discoloration of the water. Spills involving hazardous substances are defined to be reportable when they occur on the land or reach a waterway in quantities exceeding those specified by the regulations (40 CFR 117.3).

Notification	Spill Situation
National Response Center (NRC)	"Reportable Spills"
Regional Response Center	When the NRC cannot be contacted
Colorado Department of Health	"Reportable Spills"
Colorado Division of Wildlife	Danger to fish, etc., in surface water supplies
Water Quality Control Division Colorado Department of Health	Contamination of water supplies
Colorado Highway Department	Move vehicles, control traffic
Oil Shale Project Office	All spills
BLM, USFS, Downstream water users	Certain cases
Local, city, fire, police, health departments	Major spills

TABLE 7-5

Oil and Hazardous Substance Inventory

Material Stored	Storage Site No. **	1979 Storage BBL	1980 Storage BBL	1981 Storage BBL	1982 Storage BBL	1983 Storage BBL	1984 Storage BBL	1985 Storage BBL
Plasticrete	15	50	50	90	1	1	1	1
Diesel Fuel	16	830	2,950	3,000	1,500	250	350	350
Gasoline	16	35	645	1,000	500	145	180	180
Motor Oil & Grease	*	0	0	70	50	20	18	18
Chlorine	15	10	10	0	0	0	0	0
LPG	*	190	850	837	595	305	300	300
Shale Oil	40	0	0	244	0	0	0	0
Sulfuric Acid	43	30	100	100	24	20	20	15

* Stored at numerous locations on construction site.

**See Figures 4-2 and 4-3.

7.3.4 Spill Response Team

All spills are the responsibility of an in-plant Spill Response Team which will be specifically organized and trained for this purpose. A Spill Response Coordinator (SRC) has the primary responsibility for deciding the action required and assembling the necessary team elements (see Table 7-6).

7.4 Waste Disposal

The 9,000 gallon-per-day sewage treatment facility was not in operation during 1985. At present, the sewage is being disposed via porta-johns; and an approved sewage system that has been in operation for nine years is utilized to dispose of that from the C-b offices. Solid waste (trash) accumulated in waste bins was trucked off-site as frequently as necessary to an approved landfill in Meeker; total amount for 1985 was approximately 300 cubic yards.

7.5 Erosion Control

Nine erosion basins, constructed prior to 1985, remain at C-b Tract controlling run-off from disturbed sites. Sediment was mucked out of these structures during 1985. They were monitored throughout the year and no leaks or any visible sign of oil were detected.

As a result of intense storms, overflow of erosion basins has been experienced and noted in the 1984 Annual Report. Action was taken in 1985 to solve this problem. First, basin # seven (in Brown and Root Area) was enlarged. Second, run-off from the west mine site area is diverted from original basin #1B and routed north along east side of the CB access road to basin # seven. Also a rock/sediment trap was constructed in drainage to erosion basin # five near Pond A. The purpose of this work was to catch overland flow to basin # five and provide a trap for rock/sediment which periodically plugged a culvert under a road upstream from this basin.

7.6 Historic, Scientific, and Aesthetic Values Protection

As part of the Lessee's plan to protect these assets, archaeological and scenic-value studies have been undertaken on the Tract and surrounding area and

TABLE 7-6

Spill Response Team Members

Spill Response Coordinator	S. L. Stringer
Cleanup Coordinator	S. L. Stringer
Government Liaison Coordinator	E. B. Baker
Public Relations Coordinator	M. D. Talbert
Legal Coordinator	K. G. Kofford
Environmental Protection Coordinator	E. B. Baker
Procurement and Logistics Coordinator	C. H. Hynes
Document Coordinator	T. H. Pysto
Accounting Coordinator	R. E. Moore
Training Coordinator	E. B. Baker
Safety and Security Coordinator	K. G. Kofford

reported in prior years; in 1985 no new studies were conducted or needed. In view of the relatively light Tract activities in 1985 no archaeologic "findings" were expected, nor reported.

7.7 Health, Safety and Security

7.7.1 Program and Services

7.7.1.1 General

CB management is committed to maintain a safe working environment for all employees. Although all risks cannot be completely eliminated, CB will provide and maintain working conditions which are as safe and healthful as modern state-of-the-art safety and industrial hygiene practice can provide. A comprehensive health, safety, and security program is in place and will be maintained to ensure that these objectives are achieved.

Currently the health and safety functions are served directly by both the Director of Operations and the Operations & Maintenance Superintendent. All personnel are trained in first aid and St. Mary's Flight for Life aircraft helicopter is available for extreme medical emergencies twenty-four hours a day.

7.7.1.2 Manhours/Accident Frequency Rate

Following are figures depicting the manhours and accident frequency rate for 1985 at the C-b Tract:

	Manhours	Reportable Accidents	Incident (a) Rate
CB	31,163	0	0
Contractors	10,003	0	0
TOTAL	41,166	0	0

(a) Incident Rate = $\frac{\text{No. of Reportable Accidents} \times 200{,}000}{\text{Hours of Employee Exposure}}$

7.7.1.3 Inspections and Violations

Cathedral Bluffs had a total of eleven MSHA inspection days during 1985. There were three citations received during 1985; all of which have been abated.

7.7.2 Possible Health Hazards

7.7.2.1 Dust

Dust is controlled on unpaved sections of roadways by the application of water and/or dust suppressant on an as-needed basis. Dust is controlled during rock drilling operation by the use of water. Although there have been no surveys conducted yet to determine full-shift mine employee exposure to dust, it is not anticipated that problems exist in this area. If dusty conditions were encountered, the condition would be mitigated by changing ventilation, use of water sprays, or a dust palliative. Respirators would be used if compliance with standards could not be otherwise achieved.

7.7.2.2 Noise Control

Occupational noise control for employee protection is accomplished where feasible by equipment design. When this approach is not feasible, or when engineering design does not reduce noise levels below the maximum allowable limit, all exposed persons will be required to wear ear protection.

7.7.3 Fire Control

Fire control training has been provided for both surface and underground situations.

The fire control systems utilized at the C-b Tract include the following:

° Dry chemical hand-held and wheeled fire extinguishers for protecting all buildings, including headframes.

- o Twin agent (dry chemical/water foam) trailer extinguishers for large fire protection.

- o A portable water tank (trailer mounted) available for use in extinguisher brush fires that might develop on-site.

7.7.4 Gas

The mine was classed as gassy on January 2, 1980 by the Mine Safety and Health Administration (MSHA). During 1985, methane was checked on a continuous basis by use of a mine monitoring system which has stations throughout the mine levels (Table 4-4). Logs of that activity are kept on site. No hazardous concentrations of methane were detected during 1985.

7.7.5 Explosives Handling and Storage

Explosives needed for mining and surface construction use are stored in remotely located surface magazines (facilty #63, located on Figure 4-6) which meet the criteria of the appropriate regulatory agencies. Explosives handling and transportation from magazine to the work site are conducted only by experienced, trained workers. Damaged and outdated explosives are burned in a remote location on Tract by trained personnel under appropriate permit or returned to the explosives' dealer for proper disposal.

7.8 Fish and Wildlife Plan

7.8.1 Objectives of the Fish and Wildlife Plan

In 1985 several special studies were implemented. These included: a deer bite count study; a fecal and stomach analysis study and a coyote/deer interaction study.

7.8.2 Mitigative Actions

7.8.2.1 Sagebrush Beating

Success of the sagebrush beating program has been evaluated the past 4 years with no evidence obtained for increased numbers of deer (higher pellet-group densities) in brush beaten areas. The same analysis (2-level ANOVA*) was again conducted this year (Table 7-7). Again, differences between treatment and control areas were nonsignificant ($F = 2.07$; df = 1,7; $P > 0.20$). The significant F value of 9.06 refers to the differences among the control plots.

For the past 4 years, comparisons have been made of cottontail use between brush beaten and unmodified sagebrush areas. Results to date, including this past year, have consistently shown lower frequencies of cottontail pellets in the brush beaten plots (for 1984-85 $F = 2.45$, df = 7, $P<0.05$). Brush beating, therefore, appears to have a negative effect on cottontail populations.

Casual observations noted that deer are still using the edges of the brush beaten areas and the side slopes, whereas the cattle tend to remain in the brush beaten areas. Sagebrush density is increasing more rapidly in the Gardenhire beating area than in the Oldland beating area. The differences between the two beatings are probably the result of several factors including: 1) Oldland Gulch had a taller, more mature stand of sagebrush than the stand in Gardenhire, which made it possible to achieve a higher percent of kill on the sagebrush plants; 2) the Oldland area was seeded before beating and the Gardenhire area was seeded and harrowed after beating.

7.8.2.2 Serviceberry Brush Beating

The BLM completed the brush beating using C-b's brush-beater in November 1984. The project was done to stimulate browse production thereby increasing deer use in the area. Half of the area was chopped by pulling the rollers in tandem, and the other half was chopped with the rollers pulled side by side.

*ANOVA = Analysis of Variance

TABLE 7-7 Comparison of mule deer pellet-group counts between brush-beaten sagebrush and control areas.

1985

TWO-LEVEL NESTED ANOVA:

Source of Variation	DF	MS	F	Variance Components
Between brush-beaten and control areas	1	0.83	2.07	4.9%
Among subgroup plots	7	0.50	9.06	27.3%
Within plots	171	0.06		67.8%

F (.10; df=1,7) = 3.59 F (.10; df=7,171) = 1.75

Transect Means +/- SE (n) =

Brush-beaten		Control	
BA41	0 +/- 0 (20)	BA43	20 +/- 9 (20)
BA42	55 +/- 20 (20)	BA44	260 +/- 46 (20)
BA45	45 +/- 20 (20)	BA47	160 +/- 54 (20)
BA46	30 +/- 16 (20)	BA48	105 +/- 26 (20)
		BA49	10 +/- 7 (20)

Small islands of trees were left for cover. The entire test area was seeded using a tractor with a broadcast seeder. The seed mixture was the permanent C-b seed mixture which includes browse species as well as forbes and grasses. The deer pellet transects were reinstalled and swept after the beating was completed. To date, one year of pre-treatment data and one year of post-treatment data has been collected (Table 7-8). Deer use was almost three times as high in the control area versus the beating after the first year (1.66 vs. 0.65; mean pellet groups/0.01 acres). This difference was expected since the area is newly disturbed with little new growth to attract the wildlife. Lagomorph abundance was also lower in the treatment area than the control area.

See section 9.3.11.2 for the results on the vegetation studies being conducted in the serviceberry area.

With the increased young shoot production on the serviceberry there should be an increase in deer use in the beaten area. Measurements on serviceberry production was done in the fall of 1985 and will be compared to utilization rates in the spring of 1986.

7.8.2.3 Deer Reflector Study

The deer reflector study was suspended after the 1984-85 field season due to low volume of deer kills in the study area. The study may be resumed when deer kills along the highway increase enough to obtain an adequate sample size (it was stated in a previous report that at least 100 deer need to be lost within the study area to statistically determine the effectiveness of the reflectors).

During the 1984-85 season, 10 deer were killed in the study area; 5 with the reflectors on and 5 with reflectors covered (Table 7-9). This brings the total number of deer killed within the study area to 41 compared to 209 along the entire Piceance Creek Highway. Forty-one percent of the deer have been killed with the reflectors covered while 59% were killed while the reflectors were on. The reflectors seem to be decreasing the deer kill but the

TABLE 7-8

DEER PELLET-GROUP DENSITIES
SERVICEBERRY

Before Beating (1984)		After Beating (1985)	
Transect	Pellet-Group mean +/-SE(n)*	Transect	Pellet-Group mean +/-SE(n)
BA51(control)	2.05 +/-0.37 (20)	BA51	2.00 +/-0.48 (20)
BA52(control)	3.45 +/-0.60 (20)	BA52	1.35 +/-0.28 (20)
BA56(control)	1.65 +/-0.32 (20)	BA56	1.65 +/-0.23 (20)
Average	2.38		1.66
BA53(beaten)	2.10 +/-0.35 (20)	BA53	0.40 +/-0.18 (20)
BA54(beaten)	2.50 +/-0.38 (20)	BA54	0.50 +/-0.15 (20)
BA55(beaten)	2.85 +/-0.46 (20)	BA56	1.05 +/-0.27 (20)
Average	2.48		0.65

* n = number of 0.01 acre plots sampled.

TABLE 7-9 Piceance Creek Deer Reflector Data
FEBRUARY 1982 - MAY 1985

MILE MARKER

Reflectors	9	13	17	19
ON	4	2	7	4
COVERED	9	4	6	5

DEER KILLED

Reflectors	Male	Female	Unknown	Adult	Fawn
ON	4	12	1	10	6
COVERED	5	16	3	10	13

Deer killed with reflectors ON = 17 = 40%
Deer killed with reflectors COVERED = 24 = 60%
Total killed in Test Area = 41

DEER ROADKILL

Year	Reflector Area ON	Reflector Area OFF	Piceance Creek Highway
81-82 (2-11 thru 4-30)	2	3	32
82-83	6	11	60
83-84	4	5	66
84-85	5	5	51
TOTAL	17	24	209

actual effectiveness still can not be determined due to the limited sample size. Again, it should be noted that several of the deer killed during the three year study period may have been killed during daylight hours when the reflectors do not work, which could bias the results.

7.8.3 Water Development

The seven water catchment basins that were built in 1984 to catch spring run-off provided additional water holes for both wildlife and livestock during the 1985 season. Existing tanks were kept full during the early spring and fall.

7.8.4 Deer Radio Telemetry Study

Since 1981, the Department of Energy has been funding a deer radio-telemetry on C-b Tract. The primary objectives of the study are to determine migration pathways, seasonal movements, and mortality of mule deer inhabiting areas being developed as Federal Prototype Oil Shale leasing sites in the Piceance Basin. The following is the abstract from the Fiscal Year 1985 Report by Garrott and White:

> "In the fall of 1984 sixty fawns were radio collared on both the C-b Tract and Little Hills study areas, bringing the total instrumented population in Piceance Basin to 160 at the onset of winter. The large data base collected during the previous four years of study coupled with budgetary constraints resulted in the termination of the movement studies in November 1984. Deer show strong fidelity to both their individual summer and winter ranges and appear to use the same migratory route to travel between the two. Timing of the fall migration remains consistent between years and is not stimulated by snow storms. Spring migrations varied by as much as a month from year to year and appear to be correlated with winter severity. Adult doe winter survival was 85% for the instrumented C-b Tract populations and 100% for Little Hills animals. Fawn survival was 9% for the C-b Tract animals and 31% for Little Hills animals. The high fawn mortality for C-b Tract animals is attributed to an

increase in predation rates from an average of 44% of the instrumented population during winters 1980-81 through 1983-84 to 77% this past winter. Both coyote and bobcats were responsible for the increased predation. For the third consecutive year at least 40-50% of the instrumented fawns in the Little Hills area succumbed to starvation. These relatively high losses even during "normal" winters (1982-83 and 1984-85) suggests that adequate forage may not be available for the number of deer wintering on the Little Hills range."

Cathedral Bluffs Shale Oil Company has provided data, manpower, and some financial assistance to the study.

7.8.5 Mule Deer Bite Count Study

This study was initiated to obtain more information on mule deer food preferences which would aid in mitigation and reclamation planning. The study was designed to record and evaluate what species the deer were eating in different habitat types and during different seasons.

The results were inconclusive due to the small sample size. Only 383 were observed during the study period. The major reason for the small sample size was that the deer would not allow the observer to get close enough to note their food preferences (Note: many deer would move 10 to 50 meters and then start feeding again. Study guidelines disallowed recording bites if the deer were disturbed and moved from the location they were first seen).

Over 80% of the observations were collected in March and April. Study results showed a high preference for the new emerging grasses (70%), then artemisia spp. (14%), chyrsothamnus spp. (6%) and then equal preferences (3%) for Amelanchier spp., Purshia tridentata and pinus edulis.

Conclusion

Unless a method of observing the deer without disturbing them can be found, this study should not be continued since only limited and possibly biased data would be obtained.

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Conclusion

Unless a method of observing the deer without disturbing them can be found, this study should not be continued since only limited and possibly biased data would be obtained.

7.8.6 Deer Fecal and Rumen Analysis

The fecal and rumen study was conducted to obtain additional information on deer/cattle food preferences.

Fecal samples were collected for both deer and cattle in four different habitat types: mountain shrub, chained pinyon, juniper, sagebrush draw, and hay meadow. Sampling was conducted where use was heavy in the areas. Rumen samples were collected from roadkills.

Data showed little dietary overlap between deer and livestock in the four areas sampled (Table 7-10). Deer showed a preference for browse while cattle preferred mostly grasses. The only area competition was in the mountain shrub area where deer and cattle both preferred chyrsothamnus (7% vs 14%, respectively).

7.9 Off-Tract Corridors

Comments on the draft BLM Resource Management Plan (RMP) for the Piceance Basin were sent to the BLM in June 1984. A corridor west then north to the present 8-5/8 inch transmission pipeline owned by Rocky Mountain Natural Gas Company was identified as a potential C-b corridor. A north corridor to the LaSal pipeline corridor is another C-b alternative shown in the RMP. CB will notify the BLM when corridor plans are finalized.

7.10 Abandonment

The Abandonment Plan is contained in Supplemental Material to the Detailed Development Plan Modification submitted July 1977. The plan is still valid. It will be updated in a Revised Detailed Development Plan (RDDP) prior to new major construction.

7.11 Permit Status

A CB Permit Status Report of all required environmental permits and approvals for current and near-term construction operations obtained to date is

TABLE 7-10 - DEER FOOD STUDY
1985

Genus	Deer -- 1F Gardenhire		Cattle -- 5F Gardenhire		Deer -- 2F Pond C		Cattle -- 6F Pond C		Deer -- 3F SG-18		Cattle -- 7F SG-18		Deer -- 4F Hayfield		Cattle -- 8F Hayfield	
	x	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
Agropyron	0	0	2.48	3.60	0	0	6.33	2.18	0	0	67.37	5.55	4.96	3.65	30.56	5.30
Bromus	0	0	21.76	9.38	0	0	29.31	4.76	0	0	8.12	1.47	.53	1.18	13.53	6.89
Carex	0	0	.85	1.90	0	0	0	0	0	0	1.37	1.89	0	0	10.53	5.06
Elymus	0	0	40.39	9.65	0	0	23.95	4.64	0	0	.59	1.32	0	0	31.67	4.88
Festuca	0	0	9.43	3.64	1.03	1.41	0	0	0	0	0	0	5.65	5.11	5.99	2.49
Koeleria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poa	0	0	2.66	4.09	0	0	2.42	3.67	0	0	3.84	2.61	0	0	0	0
Sitanion	0	0	0	0	0	0	1.63	2.23	0	0	0	0	0	0	0	0
Berberis	0	0	0	0	5.18	.25	0	0	7.24	2.71	0	0	6.14	2.36	0	0
Artemisia tridentata	23.80	5.62	0	0	8.61	3.06	0	0	0	0	0	0	59.60	7.43	0	0
Cercocarpus	0	0	0	0	61.29	8.03	1.53	2.09	60.24	5.56	9.18	5.97	0	0	0	0
Chenopodium	0	0	0	0	0	0	0	0	1.59	2.42	0	0	0	0	0	0
Chrysothamnus	16.27	3.68	0	0	6.86	2.43	14.19	2.69	4.79	2.17	0	0	0	0	0	0
Composite	0	0	0	0	1.03	1.41	0	0	1.09	1.51	0	0	.63	1.41	0	0
Cryptantha	0	0	9.43	7.05	0	0	0	0	0	0	0	0	0	0	0	0
Descurainia	0	0	0	0	0	0	0	0	.50	1.11	0	0	1.79	2.65	0	0
Draba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epilobium (type)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Equisetum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurotia	0	0	0	0	0	0	14.20	7.20	0	0	2.70	1.52	0	0	0	0
Juniperus	14.78	3.34	0	0	.49	1.10	0	0	1.00	1.37	0	0	3.57	2.52	0	0
Kochia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesquerella	0	0	0	0	1.55	1.42	0	0	1.61	2.32	0	0	2.42	2.62	0	0
Lupinus	0	0	0	0	0	0	0	0	.53	1.19	0	0	0	0	.86	1.92
Mahonia repens	0	0	0	0	0	0	0	0	0	0	1.36	3.03	0	0	0	0
Medicago - Melilotus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.70	2.32

(Continued)

TABLE 7-10 - DEER FOOD STUDY
1985

Genus	Deer -- 1F Gardenhire		Cattle -- 5F Gardenhire		Deer -- 2F Pond C		Cattle -- 6F Pond C		Deer -- 3F SG-18		Cattle -- 7F SG-18		Deer -- 4F Hayfield		Cattle -- 8F Hayfield	
	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
Penstemon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Picea	38.08	3.85	0	0	0	0	0	0	.50	1.11	.74	1.65	11.71	3.88	0	0
Phlox	0	0	0	0	0	0	0	0	0	0	2.77	3.12	2.37	1.34	0	0
Pinus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Seed	0	0	10.51	3.11	0	0	4.85	3.57	0	0	1.96	1.79	.63	1.42	0	0
Sphaeralcea	0	0	2.49	2.27	0	0	1.59	2.17	1.09	1.51	0	0	0	0	0	0
Symphoricarpos	7.07	3.14	0	0	13.96	8.77	0	0	19.82	4.05	0	0	0	0	0	0
Verbascum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.16	3.71

TABLE 7-10 - DEER FOOD STUDY
1985

Genus	DEER (Dead)														CATTLE	
	9R		11F		13R		14R		15R		A(R)		B(R)		Pond C	
	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
Agropyron	1.55	2.13	0	0	0	0	0	0	0	0	0	0	0	0	64.73	2.59
Bromus	0	0	4.65	1.75	15.97	5.88	0	0	1.88	2.69	.57	1.27	0	0	0	0
Carex	0	0	0	0	3.91	2.91	0	0	0	0	0	0	.62	1.38	5.31	2.92
Elymus	0	0	0	0	8.74	1.82	0	0	.57	1.27	0	0	0	0	9.68	2.20
Festuca	0	0	0	0	12.20	2.98	0	0	0	0	0	0	2.48	2.46	1.44	1.97
Koeleria	0	0	0	0	.80	1.79	0	0	0	0	0	0	0	0	0	0
Poa	0	0	.69	1.54	0	0	0	0	0	0	0	0	0	0	0	0
Sitanion	0	0	0	0	5.47	4.46	0	0	0	0	0	0	0	0	0	0
Berberis	0	0	0	0	0	0	0	0	0	0	3.21	2.29	0	0	0	0
Artemisia tridentata	32.35	1.82	13.04	4.95	2.34	2.14	1.99	1.20	9.95	3.85	12.88	3.85	6.98	1.34	0	0
Cercocarpus	18.89	8.62	1.37	1.87	0	0	3.45	2.40	0	0	7.87	3.18	7.16	6.12	15.69	3.87
Chenopodium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chrysothamnus	24.01	5.80	15.28	2.46	39.80	6.24	72.91	4.96	9.80	3.03	18.79	7.27	30.09	6.83	0	0
Composite	2.39	3.68	0	0	0	0	0	0	1.16	2.60	0	0	0	0	0	0
Cryptantha	0	0	0	0	0	0	0	0	0	0	0	0	1.28	1.77	0	0
Descurainia	0	0	0	0	0	0	0	0	.99	1.36	0	0	0	0	0	0
Draba	0	0	0	0	.76	1.71	0	0	0	0	0	0	0	0	0	0
Epilobium (type)	0	0	0	0	0	0	0	0	0	0	0	0	2.57	2.67	0	0
Equisetum	0	0	0	0	.76	1.69	0	0	0	0	0	0	0	0	0	0
Eurotia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juniperus	2.91	1.66	19.51	6.24	0	0	6.84	3.08	23.19	4.23	15.82	1.55	13.44	4.11	0	0
Kochia	0	0	4.18	2.95	.74	1.66	0	0	0	0	3.83	2.73	0	0	0	0
Lesquerella	0	0	0	0	0	0	1.38	1.30	6.00	3.12	1.79	2.63	4.24	2.77	0	0
Lupinus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mahonia repens	0	0	0	0	0	0	1.86	1.09	17.30	2.68	0	0	0	0	0	0
Medicago - Melilotus	0	0	0	0	2.29	2.09	0	0	0	0	0	0	0	0	0	0

presented in Table 7-11 including the following categories: air, water, land, and other.

7.12 Environmental Assessments

Tenneco and Occidental maintain a policy which requires assessments for environmental compliance. Environmental assessments or systems reviews have been conducted regularly in the past.

The assessment team inspected the CB facility in 1984 and found the operation to be in compliance with all pertinent environmental regulations. At that time the team concluded there were no unreasonable or extraordinary environmental risks as a result of the present operating mode of the site. As a result of minimal activity and no operating changes since the last audit, no intercompany audit was performed during 1985.

TABLE 7-11
CB PERMIT STATUS REPORT
CURRRENT PERMITS/NOTICES

Permit Title	Purpose	Permitting Agency	Permit No.	Date Submitted	Date Approved	Date of Expiration	Remarks
Air							
1) PSD	For Ancillary Development of 5000 B/D MIS facility	EPA	N/A	10/17/77	12/15/77	N/A)	Construction commenced 1978. Twelve month extension approved by EPA and CAQCD to 11/15/86. BACT analysis due 5/15/86.
2) PSD Amendment	12,000 B/D AGR 13,000 B/D OUG	EPA	N/A	12/29/82	9/26/83	N/A)	
3) APENs (26)	AGR/OUG Emission Sources	CAQCD	82RB410 (1-26)	12/29/82	10/15/83	N/A	
4) Fugitive Dust Permit	Surface disturbance for construction of shafts & support facilities	CAQCD	C-11,454 (FD)	6/27/77	12/28/77 Rev 8/05/80	Indefinite	
5) Emission Permit	Concrete Batch Plant	CAQCD	C-11,931	5/18/78	6/23/78	Indefinite	
6) Open Burning Permit	Dynamite and Wood Disposal	CAQCD	1860-OB-0007	1/8/85	1/14/85	12/31/85	Permit has annual renewal requirement.
7) Emission Permits (4)	Natural gas generators	CAQCD	C-12,255 (1-4)	12/04/78	3/15/79	Indefinite	
8) Emission Permit	Feeder Breaker	CAQCD	C-13,244 (FD)	3/06/81	4/20/81 (State) 5/18/81 (EPA)	Indefinite	

TABLE 7-11 (CONTINUED)
CB PERMIT STATUS REPORT
CURRENT PERMITS/NOTICES

Permit Title	Purpose	Permitting Agency	Permit No.	Date Submitted	Date Approved	Date of Expiration	Remarks
Water							
1) NPDES	Water discharge to Piceance Creek	CWQCD	CO-0033961	8/19/77 Rev. 6/30/80 New appl. 6/30/82	3/27/79 12/1/80 9/30/83	 3/31/88	 Notification required prior to new construction.
2) SPCC	To comply with the Clean Water Act	CWQCD, OSPO, EPA		4/83	Not required	Update required every 3 years	Revision submitted 4/83. Revision due 4/86.
3) Water Augmentation Plan	Depletion mitigation	Water Court	W-3492	8/31/77	5/21/79	Project Life	Augmentation Plan status report presented 11/85 to Water Court. Extension to 1988 granted pending final approval by parties.
4) Well Permits (34)	Covers permits for 29 wells and 5 shafts filed under Augmentation Plan for any beneficial use.	State Engineer	W-3493	8/31/77	5/21/79	N/A	
5) Sewage Plant Site Approval	Sewage plant	CWQCD	Site 2852	8/06/80	8/28/80		Site transferred to existing package plant.
6) Sewage Plant	Sewage disposal	CWQCD	Site 2852	9/22/80	11/03/80	Indefinite	9000 gpd capacity.
7) Operators License	License for water and wastewater plant operator	CDH	No. 1494 1535 1505		10/82	10/87	During construction licensed contract personnel were utilized.

TABLE 7-11 (CONTINUED)
CB PERMIT STATUS REPORT
CURRENT PERMITS/NOTICES

Permit Title	Purpose	Permitting Agency	Permit No.	Date Submitted	Date Approved	Date of Expiration	Remarks
Land							
1) Lease	Tract C-b development	BLM	C-20341		4/74	4/96	Annual payment due prior to 3/31/86. Semi Annual Data Report due 2/86.
2) DDP & MDDP	Lease compliance	BLM/OSPO	N/A	2/77	8/77	Life of Lease	1983-84 Interim Plan approved 2/23/83. with extension submitted 5/85 for IMP through 3/86.
3) Monument Peak Right-of-Way	Microwave communi-cations	BLM	C-25677	7/31/77	10/20/77	10-19-2007	Annual rental payment required 10/19/86.
4) Road Right-of-Way	Construct access road	BLM	C-15827 RW	9/77	1/24/78	Concurrent with C-b Lease C-20341	Ten year term rental payment due for renewal 1/23/88.
5a) 302 Permit	Operation and Mainten-ance of Monitoring Wells (SG-18,19,21,A5A,Federal 2-B, TG2-3,TG2-1,71-3, 71-5), air quality stations and visibility site.	BLM	CO-010-P-WR-83-16	5/83	6/15/83	6/15/86	Payment required (6/15/86). Added vis-ibility site 1/84. Term is three years.
5b) Right-of-Way	Access to 5a (302 Permit Areas)	BLM		5/83	6/15/83	6/15/86	Per BLM Letter of 3-6-86, access and site are separate permits.
6) Right-of-Way	Water Storage Tank and Pipeline	BLM	C-40606	12/17/85	12/30/85	12/29/2015	
7) Mined Land Reclamation Plan	Surface disturbance reclamation	CMLRB	77-530	11/07/77	3/23/78	Life of Project	Covers MIS development and 710 acres surface disturbance. Amendment re-quired for AGR spent shale disposal prior to construction of AGR proces-sing facilities. Annual reclamation report and fee submitted 3/22/85. Next fee and report due 3/23/86.

TABLE 7-11 (CONTINUED)
CB PERMIT STATUS REPORT
CURRENT PERMITS/NOTICES

Permit Title	Purpose	Permitting Agency	Permit No.	Date Submitted	Date Approved	Date of Expiration	Remarks
Land (cont'd)							
8) Special Use Permit	Permanent zoning	Rio Blanco County		10/10/78		Indefinite	Follows original DDP, includes AGR. Status confirmed by resolution 7/5/83. Impact analysis is included in 1983 Major Development Permit application for addition to OUG and construction housing.
9) Power Utility Corridors	Power lines	Rio Blanco Co BLM/White River Electric's #C-26839		6/2/78	6/80	6/2010	138 KVA White River Electric line (constructed) will serve project. Permit maintained by White River
Solid Waste							
Resource Conservation and Recovery Act (RCRA)							
1) Notice of hazardous waste activity	Generate & ship hazardous waste	EPA	EPA ID# COD 000 716530	8/18/80	N/A	N/A	There are no current hazardous waste activities. Semi-annual status report submitted 2/86.
Other							
1) Notice to FAA of Proposed Construction	Structures over 200 ft	FAA		8/18/78	None Required	N/A	Proper notification made. No further action needed.
2) Heliport Location	Heliport construction	DOI/OSPO, FAA		11/8/79	N/A	N/A	
3) Radioactive Materials License	Operate neutron moisture probe for soil moisture monitoring of spinkler plots.	Colo.Dept. Health	Colo 437-01	5/01/80	6/28/80	7/31/90	Renewal submitted 5/3/85, approved 8/23/85. Source tested every 6 months. Source last tested 9/85.

TABLE 7-11 (CONTINUED)
CB PERMIT STATUS REPORT
CURRENT PERMITS/NOTICES

Permit Title	Purpose	Permitting Agency	Permit No.	Date Submitted	Date Approved	Date of Expiration	Remarks
Other (cont'd)							
5) TSCA-Inventory Chemical Substances	Registration of shale oil	EPA	N/A	4/26/78	N/A	N/A	Shale oil is on the inventory of of existing chemical substances.
6) Hoistman Certificate	Hoist operator	MSHA					Current certificates posted in Hoist Room.
7) Explosive Users Permit	Buy, transport, use explosives	BATF			3/85	N/A	Permit with manufacturer.
8) Permit to Store and Use Explosives	Use/storage	CDM			1/85	N/A	

8.0 SOCIOECONOMIC ACTIVITIES

8.1 Workforce

At the beginning of 1985 the CB Project employed a total of 61 persons. A total of 23 persons were employed at the end of 1985, 16 of those located at the main office in Grand Junction and 7 located at the Tract.

8.2 Area Employment and Population

Unemployment in both Rio Blanco and Garfield counties declined substantially during 1985, but did not vary significantly from 1984 overall according to the Colorado Department of Labor and Employment. The unemployment rate in Garfield County decreased from 10.5 percent in January to 7.6 percent in December, 1985, while in Rio Blanco County the unemployment rate decreased from 6.9 percent to 4.8 percent. Garfield County experienced declining unemployment but a relatively stable total labor force, indicating that population in the county remained stable throughout the year. Rio Blanco County experienced a slight increase in its total labor force.

8.3 Transportation

Traffic counts along major highways in the Project area continue to be much lower than those experienced in 1981, and well below the design capacities of those local roadways.

8.4 Housing

The only housing which the CB Project has retained in the area is the 101 space Kings Crown Mobil Home Park in Rifle. Space in this park is available to the general public.

8.5 Socioeconomic Mitigation

Numerous meetings were held during 1985 with local government jurisdictions affected by the CB Project for the purpose of developing an overall Project Socioeconomic Mitigation Plan.

CB continued to participate in the Cumulative Impacts Task Force, an organization of local government, state government and industry, working to identify the cumulative socioeconomic effects of the energy industry.

8.6 Community Donations

Table 8-1 lists the budgeted contributions made by CB to various community projects in 1985.

TABLE 8-1

Cathedral Bluffs

Contribution Status Schedule

As Of December 31, 1985

	Total for Year
Mesa County Economic Development	$10,000.00
Flight for Life (St. Mary's)	2,400.00
Rio Blanco County Fair	2,480.00
Pioneer Hospital	5,000.00
Mesa County Bar	500.00
Colorado Water Congress	250.00
Miscellaneous	2,420.00
TOTAL	$23,050.00

9.0 ENVIRONMENTAL MONITORING

9.1 Scope

The Environmental Baseline Period for Oil Shale Tract C-b covered the period from November 1, 1974 to October 31, 1976. Results have been reported in nine Quarterly Data Reports, eight Quarterly Summary Reports, C-b Annual Summary and Trends Report (1976), and a five-volume Environmental Baseline Program Final Report (1977), all submitted to the Manager of the Oil Shale Project Office.

From November 1, 1976 through August 31, 1977, the C-b tract was under a period of suspension of the Federal Oil Shale Lease. The monitoring conducted during this period was executed under a program known as the Interim Monitoring Phase. Environmental data for this time period were submitted to the Oil Shale Project Office (OSPO) on October 14, 1977 (Interim Monitoring Report #1). The Interim Monitoring Period was later extended by the OSPO to cover the period from September 1, 1977 through March 31, 1978. Data for this time period were submitted to the OSPO on May 15, 1978 (Interim Monitoring Report #2). The Development Monitoring Program was initiated in April, 1978. The Development Monitoring Program for Oil Shale Tract C-b was submitted to the OSPO in a document dated February 23, 1979 and approved by the OSPO on April 13, 1979 subject to thirteen Conditions of Approval contained in the approval letter. Development Monitoring again reverted to Interim Monitoring status in March, 1982 as approved by the OSPO and has continued at that level to date. Actually an Interim Development Program and Schedule were approved on July 22, 1982 as Detailed Development Plan amendments. Interim monitoring has recently been extended into 1985 by the OSPO. On December 20, 1985 a further refinement of the IMP was approved by the OSPO. This program will reflect the level of activity at the tract through 1986 and into 1987 and not compromise the hydrologic baseline already collected. Semi-annual environmental data reports are submitted every January 31 and July 31.

In the summer of 1984 unauthorized woodcutting activities by a commercial cutter occurred in the Bailey Ridge area of the tract. The site affected by the woodcutting activity was the control site for the pinyon-juniper woodland

vegetation community, known as (Open) Plot 6 (or computer code BJ16) at location T3S, R96W, Section 9 (SE1/4,SW1/4,SW1/4). Therefore a program to initiate supplemental baseline monitoring in this affected area was submitted to the OSPO on November 5, 1984 and approved by that office on November 19, 1984. Monitoring was initiated in 1985 at this site and included phytosociological studies (community structure and composition), vegetation productivity studies, re-establishment of the deer and avifauna transects, and installation of a microclimate station.

9.2 Purpose

The purpose of the Annual Report is to fulfill the requirement of the Lease to provide the OSPO with an annual summary of environmental monitoring. The Development Monitoring Plan states the following objectives with respect to environmental monitoring:

> The purposes or objectives of environmental monitoring as defined in Section 1(C) of the Lease Stipulations are to provide: (1) a record of changes from conditions existing prior to development operations, as established by the collection of baseline data, (2) a continuing check on compliance with the provisions of the Lease and Stipulations, and all applicable federal, state and local environmental protection and pollution control requirements, (3) timely notice of detrimental effects and conditions requiring correction, and (4) factual basis for revision or amendment of the Stipulations.

9.3 Summary of Environmental Monitoring

Environmental monitoring is continuing on Tract C-b. Development activities which commenced in 1978-79 have ceased with the construction of three mine shafts and associated headframes and equipment. At present one shaft was flooded (V/E) to eliminate pumping costs during this interim period. The other two shafts are being maintained by pumping and any remedial work which may be needed. All activities are being conducted within strict adherence to environmental, permit and lease regulations.

vegetation community, known as (Open) Plot 6 (or computer code R316) at location T3S, R98W, Section 9 (SE1/4,SW1/4,SW1/4). Therefore a program to initiate supplemental baseline monitoring in this affected area was submitted to the OSPO on November 5, 1984 and approved by that office on November 19, 1984. Monitoring was initiated in 1985 at this site and included phytosociological studies (community structure and composition), vegetation productivity studies, re-establishment of the deer and avifauna transects, and installation of a microclimate station.

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9.3.1 Indicator Variables

The environmental monitoring program has been brought into sharper focus with the identification of Class I indicator variables. These are key environmental variables collected at representative stations in at least monthly sampling frequency. Time series plots, generated by the computer from the data base for many of these variables, appear in the 6-month Data Reports submitted to the OSPO.

9.3.2 Tract Imagery

Tract imagery, in the form of color infrared panoramic photographs of vegetation around springs and seeps and use of Landsat for assessment of general vegetative conditon, has been discontinued since 1982 in view of decreased Tract activity, with OSPO approval.

9.3.3 Hydrology and Water Quality

The environmental monitoring program provides hydrologic and water quality data for the purpose of evaluation of potential impacts. Surface streams, springs, seeps, alluvial and bedrock aquifers, and precipitation are currently monitored. CB is now operating under an Interim Monitoring Plan which was included in the January 31, 1986 data report. However, this plan was modified slightly at the request of CB to the OSPO on November 12, 1985. All monitoring will follow this approved modified plan which is included as Table 9-1a in this report.

In September 1985 a program was completed to recondition 13 deep bedrock wells at CB that were not working properly or were blocked and thus not giving reliable data. These wells were recompleted and are now included in the January 31, 1986 approved monitoring program. With completion of this program, a monitoring network is now in place that is designed to monitor the aquifer zones as discussed in the 1984 annual report. The old upper-lower aquifer concept has been subdivided into the following hydro-stratigraphic zones:

TABLE 9-1a
Interim Monitoring Program
(November 1985 Revised)

Observation Wells

Computer Code	Designation	Formation	1985-86 -----Frequency----- Levels	Water Quality
WA01	A-1	ALLUVIUM	Q	A/F
WA02	A-2	"	Q	SA/F
WA03	A-3	"	Q	SA/F
WA04	A-4	"	Dry	-
WA05	A-5	"	-	SA/F
WA55	A-5A	"	Q	SA/F
WA56	A-5B	"	Q	A/F
WA06	A-6	"	Q	A/F
WA07	A-7	"	Q	A/F
WA08	A-8	"	Q	-
WA09	A-9	"	Q	A/F
WA10	A-10	"	Dry	-
WA11	A-11	"	Q	-
WA12	A-12	"	Q	SA/F
WA13	A-13	"	Dry	-
WA21	A-102-1	"	Q	A/L
WA22	A-102-2	"	Q	A/L
WA24	A-102-4	ALLUVIUM	Q	A/L
WD03	CB-1R	UINTA	M	SA/F
WD02	CB-2	UPC1/UINTA	M	-
WE03	CB-3	UPC2	M	SA/F
WE04	CB-4	UPC2	-	-
WG12	SG-1-1	LPC3	M	-
WD12	SG-1-2	UPC1/UINTA	M	-
WE11	SG-1A-1	UPC2	M	-
WD11	SG-1A-2	UPC1	M	-
WE61	SG-6-1R	UPC2	M	-
WG61	SG-6-2	LPC3	M	-
WD61	SG-6-3	UPC1/UINTA	M	-
WY81	SG-8R	LPC4/LPC3	M	SA/F
WG91	SG-9-1	LPC3	M	SA/F
WE91	SG-9-2R	UPC2	M	-
WD91	SG-9-3	UPC1	M	-
WC91	SG-9-4	UINTA	M	SA/F
WG51	SG-10A-1	LPC3	-	-
WE51	SG-10A-2	UPC2	-	-
WD51	SG-10A-A	UPC1/CON.UINTA	-	-
WD90	SG-10	UPC1	Q	-
WG52	SG-11-1R	LPC3	M	-
WE52	SG-11-2	UPC2	M	-
WD52	SG-11-3	UINTA	M	-
WG17	SG-17-1	LPC3/UPC2	-	-
WE17	SG-17-2	UPC2/LPC3	-	-
WD17	SG-17-3	UPC1	M	-
WC17	SG-17-4	UINTA	M	-
WD57	SG-17A	UINTA	M	SA/F
WG18	SG-18-1	LPC3	M	SA/F
WE18	SG-18-2	UPC2	M	SA/F
WD18	SG-18-3	UINTA	M	-
WD19	SG-19	UPC1	-	-
WG20	SG-20-1	LPC3	-	-
WE20	SG-20-2	UPC2	M	SA/F
WD20	SG-20-3	UPC1/UINTA	M	-
WH21	SG-21-1R	LPC4	M	SA/F
WG21	SG-21-2R	LPC3	M	-
WE21	SG-21-3	UPC2	M	-
WD21	SG-21-4	UPC1/UINTA	M	-
WY44	AT-1	LOWER AQUIFER	-	-
WV37	AT-1A	COMPOSITE	-	-
WX38	AT-1A-1	UPPER AQUIFER	-	-
WY45	AT-1C-1	LOWER AQUIFER	-	-
WY46	AT-1C-2	LOWER AQUIFER	-	-
WX44	AT-1C-3	UPC2	M	-

TABLE 9-1a (Cont'd)

Computer Code	Designation	Formation	1985-86 Frequency: Levels	1985-86 Frequency: Water Quality
WG41	AT-1D-1	LPC3	M	-
WE41	AT-1D-2	UPC2	M	-
WD41	AT-1D-3	UPC1	M	-
WD14	14X-7-1	UPC1	-	-
WD15	14X-7-2	UPC1	-	-
WI19	22X-17	UPC2	M	SA/F
WI17	24X-17	UPC2	M	-
WD44	44X-1	UPC1/UINTA	Q	SA/F
WG46	14X-6	LPC3	Q	-
WG31	43X-1	LPC3	Q	SA/F
WD30	21Y-12	UINTA	M	-
WG23	21X12-1	LPC3	M	SA/F
WC23	21X12-2	UINTA	M	SA/F
WE22	22X1-1	UPC2	M	-
WD22	22X1-2	UPC1	M	-
WC22	22X1-3	UINTA	M	SA/F
WC03	B-102-3-1	UINTA	Q	SA/F
WB03	B-102-3-2	UINTA	Q	SA/F
WG43	43X2-1	LPC3	M	SA/F
WE43	43X2-2	UPC2	M	SA/F
WW22	31X-12	UINTA	M	SA/F
WX32	32X-12	COMPOSITE	M	-
WW32	32Y-12	UINTA	M	SA/F
WW13	41X-13	UINTA	M	-
WV10	TG-71-1	COMPOSITE	Q	-
WD42	41X-12	UNITA	M	-
U201	V/E Sh	COMPOSITE	M	-

Remote WAP* Wells

Computer Code	Designation	Formation	1985-86 Frequency: Levels	1985-86 Frequency: Water Quality
WX75	TH-5	UPPER AQUIFER	A	-
WX64	TH75-5A	UPPER AQUIFER	A	-
WY64	TH75-5B	LOWER AQUIFER	A	-
WX69	TH75-9A	UPPER AQUIFER	A	-
WY69	TH75-9B	LOWER AQUIFER	A	-
WY68	TH75-10B	LOWER AQUIFER	A	-
WX65	TH75-13A	UPPER AQUIFER	A	-
WY65	TH75-13B	LOWER AQUIFER	A	-
WX67	TH75-18A	UPPER AQUIFER	A	-
WY67	TH75-18B	LOWER AQUIFER	A	-
WX72	TH75-15A	UPPER AQUIFER	A	-
WY72	TH75-15B	LOWER AQUIFER	A	-
WY66	EQUITY 1	LOWER AQUIFER	A	-
WY70	EQUITY S1A	LOWER AQUIFER	A	-
WV01	GREENO-4-4	COMPOSITE	A	-
WY71	CER RB-D-03	LOWER AQUIFER	A	-
WY75	TG-71-3	LOWER AQUIFER	A	-
WY78	TG-71-4	LOWER AQUIFER	A	-
WY76	TG-71-5	LOWER AQUIFER	A	-
WV02	OLDLAND 3	COMPOSITE	A	-
WV03	GP-17X-BS	COMPOSITE	A	-
WV04	BUTE 25	COMPOSITE	A	-
WV05	LIBERTY BELL 12	COMPOSITE	A	-
WX73	UNION 8-1	UPPER AQUIFER	A	-
WY77	GETTY 9-4D	LOWER AQUIFER	A	-

* WAP = Wells required by the Court approved Water Augmentation Plan.

TABLE 9-1a (Cont'd)

Precipitation

Computer Code	Designation	Name of Station	1985-86 Frequency
AB23	023	CB Station 023	C
AD28	028	Lysimeter Site at Shale Pile	C

Stream Flow

Computer Code	Station Number	Description	1985-86 ---Frequency--- Dis-charge	Water Quality
WU00	09306200	Piceance Creek Near Ryan Gulch	C	P
WU07	09306007	Piceance Creek Below Rio Blanco	C	P
WU22	09306022	Stewart Gulch Above West Fork	Q	SA
WU42	09306042	Tributary of Piceance Creek (East No Name Gulch)	-	P
WU45	09306045	Piceance Creek Below East No Name Gulch	-	SA
WU48	09304800	White River Near Meeker (Below Return Flows)	C	P
WU61	09306061	Piceance Creek Above Hunter Creek	C	P
WU62	09306222	Piceance Creek At White River	C	P

Springs and Seeps

Computer Code	Designation	1985-86 -------Frequency------- Discharge	Water Quality
WS01	CB S-1	M	Q
WS02	CB S-2	M	Q
WS03	CB S-3	M	Q
WS04	CB S-4	M	Q
WS06	CB S-6	Q	Q
WS66	CB S-6A	M	Q
WS07	CB S-7	M	Q
WS08	CB S-8	M	Q
WS09	CB S-9	M	Q
WS10	CB S-10	M	Q
WS11	CB SEEP A	P	-
WS12	CB S-102	Q	Q
WS13	CB S-102A	Q	Q
WS21	CER-1	Q	-
WS22	B-3	Q	-
WS23	H-3	Q	-
WS24	F-3	Q	-
WS26	W-4	Q	-
WS28	CER-7	Q	-
WS30	P3 & P3A	Q	-
WS36	CB S-101	Q	-

A = Annually
A/F = Annual/Field Measurements
A/L = Only one of the three A-102 wells will be analyzed for lab parameters on an annual basis after review of previous lab data.
C = Continuous
M = Monthly
P = Periodically measured
Q = Quarterly
SA = Semiannual
SA/F = Semiannual field measurements

Aquifer Unit	Code
Uinta Aquifer	UN
Water Table - unconfined	UUN
Lower - confined	LUN
Upper Parachute Creek #1	UPC_1
Upper Parachute Creek #2	UPC_2
Lower Parachute Creek #3	LPC_3
Lower Parachute Creek #4	LPC_4

The Unita aquifer has been subdivided into an upper unconfined or water table unit and a confined lower unit. The Parachute Creek member of the Green River Formation has been divided into four units. The UPC_1 zone is the unit above the Four Senators to the transition from Unita Sands to Green River Shale. The UPC_2 zone extends from the top of the Mahogany to the base of the Four Senators. This zone produces approximately 60 to 80% of all groundwater at CB. The lower zones are the LPC_3 which encompasses the Mahogany to the top of the R-5 zone. The lowest unit is the LPC_4 and extends down to the base of leaching or the top fo the high resistivity (unleached) zone (R-4 unit). These subdivisions more correctly reflect the stratified nature of the CB groundwater system. Figure 9-1 shows this shows this subdivision and Table 9-2 contains the monitoring network which now corresponds to these subdivisions.

During 1985 there has been four items that potentially can effect the hydrologic monitoring program results:

1) V/E shaft flooding in 1981.
2) Dewatering of the Service and Production shafts with possible aff affects on the groundwater and surface waters.
3) Discharges from Ponds A and B to East No Name Gulch and affects o on surface springs and streams.
4) Precipitation events around the basin.

The V/E shaft was allowed to fill in accord with the approved plans in September 1981. The water level has reached an equilibrium of approximately 6,302 feet elevation. This data is represented in this report in Table 9-1b. An error was found during review of the data. In 1981, after flooding the shaft, an erroneous

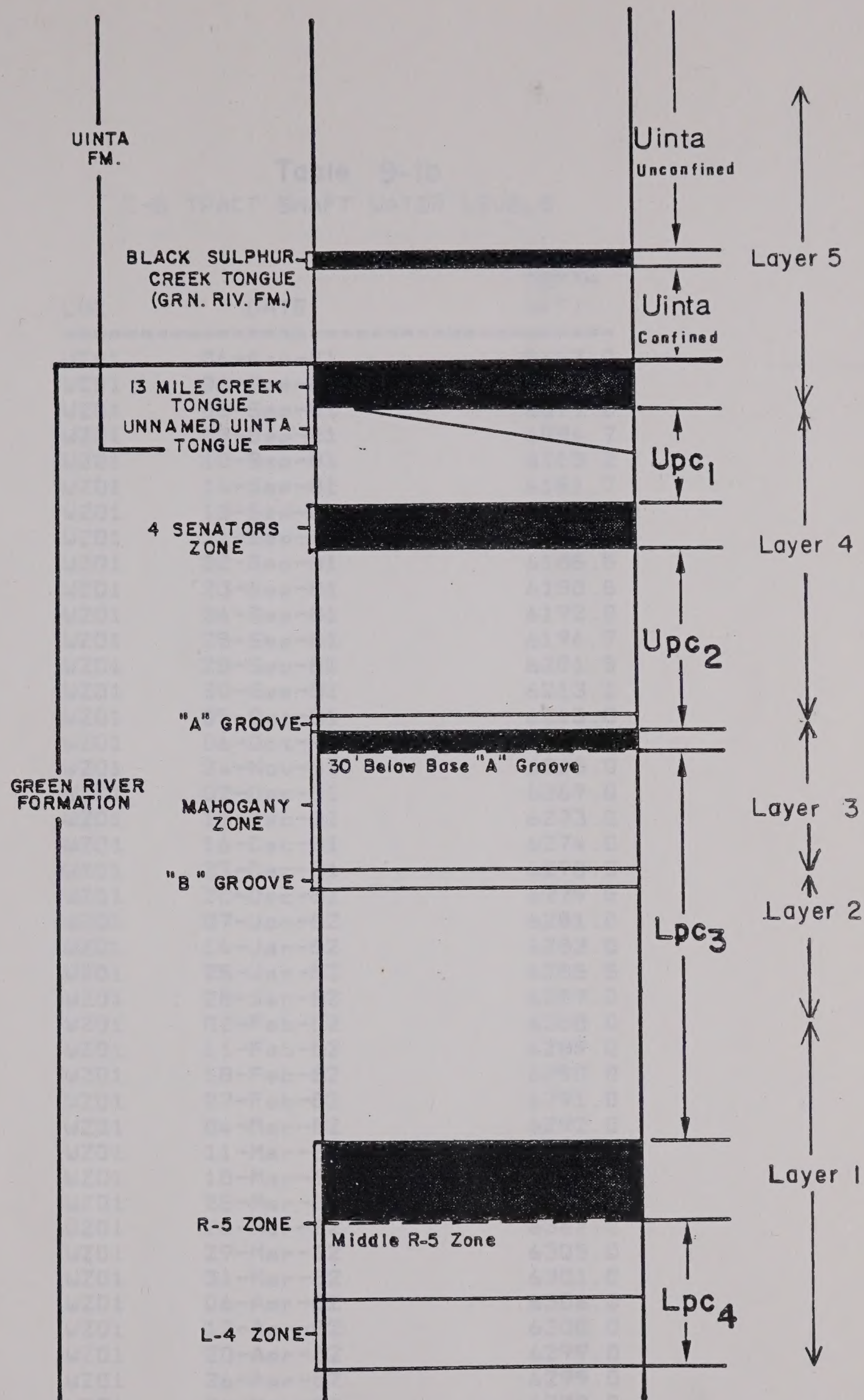


Figure 9-1 CB Aquifer Description and Subsurface Stratigraphy

Table 9-Ib

C-B TRACT SHAFT WATER LEVELS

LOC	DATE	DEPTH (FT)
WZ01	04-Sep-81	5643.0
WZ01	06-Sep-81	5979.4
WZ01	08-Sep-81	6079.5
WZ01	09-Sep-81	6094.7
WZ01	10-Sep-81	6113.2
WZ01	14-Sep-81	6151.7
WZ01	18-Sep-81	6172.0
WZ01	21-Sep-81	6185.0
WZ01	22-Sep-81	6185.5
WZ01	23-Sep-81	6188.8
WZ01	24-Sep-81	6192.0
WZ01	25-Sep-81	6194.7
WZ01	28-Sep-81	6201.5
WZ01	30-Sep-81	6213.1
WZ01	05-Oct-81	6215.0
WZ01	06-Oct-81	6216.5
WZ01	24-Nov-81	6265.0
WZ01	02-Dec-81	6269.0
WZ01	10-Dec-81	6273.0
WZ01	16-Dec-81	6274.0
WZ01	23-Dec-81	6278.0
WZ01	30-Dec-81	6279.5
WZ01	07-Jan-82	6281.0
WZ01	14-Jan-82	6283.0
WZ01	25-Jan-82	6285.5
WZ01	28-Jan-82	6287.0
WZ01	02-Feb-82	6288.0
WZ01	11-Feb-82	6289.0
WZ01	18-Feb-82	6290.0
WZ01	27-Feb-82	6291.0
WZ01	04-Mar-82	6292.0
WZ01	11-Mar-82	6293.0
WZ01	18-Mar-82	6294.0
WZ01	25-Mar-82	6295.0
WZ01	26-Mar-82	6362.0
WZ01	29-Mar-82	6305.0
WZ01	31-Mar-82	6301.0
WZ01	06-Apr-82	6306.0
WZ01	12-Apr-82	6300.0
WZ01	20-Apr-82	6299.0
WZ01	26-Apr-82	6299.0
WZ01	04-May-82	6299.0
WZ01	11-May-82	6299.0
WZ01	17-May-82	6299.0
WZ01	25-May-82	6299.0
WZ01	01-Jun-82	6300.0

Table 9-Ib con't

C-B TRACT SHAFT WATER LEVELS

LOC	DATE	DEPTH (FT)
WZ01	07-Jun-82	6300.0
WZ01	15-Jun-82	6300.0
WZ01	22-Jun-82	6300.5
WZ01	29-Jun-82	6300.6
WZ01	06-Jul-82	6300.6
WZ01	13-Jul-82	6300.7
WZ01	20-Jul-82	6300.7
WZ01	27-Jul-82	6300.5
WZ01	03-Aug-82	6300.6
WZ01	10-Aug-82	6300.6
WZ01	17-Aug-82	6300.5
WZ01	24-Aug-82	6300.5
WZ01	31-Aug-82	6300.5
WZ01	07-Sep-82	6300.6
WZ01	14-Sep-82	6300.4
WZ01	21-Sep-82	6300.1
WZ01	28-Sep-82	6300.3
WZ01	05-Oct-82	6300.2
WZ01	12-Oct-82	6299.8
WZ01	19-Oct-82	6299.6
WZ01	26-Oct-82	6299.6
WZ01	02-Nov-82	6299.4
WZ01	09-Nov-82	6299.5
WZ01	16-Nov-82	6299.2
WZ01	23-Nov-82	6299.0
WZ01	30-Nov-82	6299.4
WZ01	07-Dec-82	6298.7
WZ01	14-Dec-82	6299.3
WZ01	21-Dec-82	6298.8
WZ01	28-Dec-82	6298.6
WZ01	04-Jan-83	6298.4
WZ01	11-Jan-83	6297.9
WZ01	18-Jan-83	6297.7
WZ01	25-Jan-83	6297.7
WZ01	01-Feb-83	6297.6
WZ01	08-Feb-83	6298.0
WZ01	15-Feb-83	6297.6
WZ01	22-Feb-83	6297.4
WZ01	01-Mar-83	6297.3
WZ01	08-Mar-83	6297.1
WZ01	15-Mar-83	6296.6
WZ01	22-Mar-83	6297.0

Table 9-Ib con't

C-B TRACT SHAFT WATER LEVELS

LOC	DATE	DEPTH (FT)
WZ01	29-Mar-83	6296.7
WZ01	05-Apr-83	6296.9
WZ01	12-Apr-83	6296.9
WZ01	19-Apr-83	6296.8
WZ01	26-Apr-83	6296.8
WZ01	03-May-83	6296.7
WZ01	10-May-83	6297.0
WZ01	17-May-83	6296.9
WZ01	24-May-83	6296.0
WZ01	31-May-83	6295.7
WZ01	06-Jun-83	6294.3
WZ01	07-Jun-83	6295.1
WZ01	13-Jun-83	6294.2
WZ01	14-Jun-83	6294.9
WZ01	20-Jun-83	6294.0
WZ01	21-Jun-83	6294.8
WZ01	27-Jun-83	6295.0
WZ01	28-Jun-83	6294.7
WZ01	05-Jul-83	6294.5
WZ01	12-Jul-83	6294.6
WZ01	19-Jul-83	6294.6
WZ01	26-Jul-83	6294.7
WZ01	02-Aug-83	6294.5
WZ01	09-Aug-83	6294.5
WZ01	16-Aug-83	6294.4
WZ01	23-Aug-83	6294.4
WZ01	30-Aug-83	6294.3
WZ01	04-Oct-83	6292.8
WZ01	11-Oct-83	6292.9
WZ01	19-Oct-83	6293.5
WZ01	25-Oct-83	6293.5
WZ01	01-Nov-83	6294.2
WZ01	15-Nov-83	6296.7
WZ01	21-Nov-83	6297.7
WZ01	29-Nov-83	6297.4
WZ01	05-Dec-83	6297.7
WZ01	13-Dec-83	6297.8
WZ01	20-Dec-83	6300.1
WZ01	27-Dec-83	6302.1
WZ01	03-Jan-84	6302.4
WZ01	10-Jan-84	6303.0
WZ01	13-Jan-84	6303.2
WZ01	17-Jan-84	6303.4
WZ01	24-Jan-84	6303.2
WZ01	31-Jan-84	6303.3
WZ01	14-Feb-84	6303.2

Table 9-1b con't

C-B TRACT SHAFT WATER LEVELS

LOC	DATE	DEPTH (FT)
WZ01	21-Feb-84	6303.2
WZ01	28-Feb-84	6302.6
WZ01	06-Mar-84	6302.5
WZ01	13-Mar-84	6302.8
WZ01	20-Mar-84	6302.3
WZ01	26-Mar-84	6302.7
WZ01	03-Apr-84	6302.4
WZ01	10-Apr-84	6301.5
WZ01	17-Apr-84	6300.9
WZ01	24-Apr-84	6301.0
WZ01	01-May-84	6300.9
WZ01	08-May-84	6300.6
WZ01	15-May-84	6300.7
WZ01	22-May-84	6300.7
WZ01	29-May-84	6300.6
WZ01	05-Jun-84	6301.0
WZ01	12-Jun-84	6300.7
WZ01	19-Jun-84	6300.8
WZ01	26-Jun-84	6300.8
WZ01	03-Jul-84	6301.1
WZ01	09-Jul-84	6301.3
WZ01	17-Jul-84	6301.4
WZ01	24-Jul-84	6301.5
WZ01	30-Jul-84	6301.6
WZ01	07-Aug-84	6301.9
WZ01	14-Aug-84	6302.1
WZ01	21-Aug-84	6302.2
WZ01	28-Aug-84	6302.2
WZ01	04-Sep-84	6302.2
WZ01	11-Sep-84	6302.6
WZ01	18-Sep-84	6302.2
WZ01	25-Sep-84	6302.4
WZ01	02-Oct-84	6302.6
WZ01	09-Oct-84	6302.6
WZ01	16-Oct-84	6302.9
WZ01	23-Oct-84	6302.9
WZ01	30-Oct-84	6303.0
WZ01	06-Nov-84	6303.0
WZ01	13-Nov-84	6302.9
WZ01	19-Nov-84	6302.9
WZ01	27-Nov-84	6302.7
WZ01	04-Dec-84	6302.7
WZ01	11-Dec-84	6302.7
WZ01	17-Dec-84	6302.7
WZ01	26-Dec-84	6302.9

Table 9-Ib con't

C-B TRACT SHAFT WATER LEVELS

LOC	DATE	DEPTH (FT)
WZ01	02-Jan-85	6302.8
WZ01	08-Jan-85	6303.0
WZ01	15-Jan-85	6302.9
WZ01	22-Jan-85	6303.3
WZ01	29-Jan-85	6303.4
WZ01	05-Feb-85	6303.4
WZ01	12-Feb-85	6303.3
WZ01	19-Feb-85	6303.4
WZ01	26-Feb-85	6303.6
WZ01	05-Mar-85	6303.7
WZ01	12-Mar-85	6303.8
WZ01	19-Mar-85	6303.6
WZ01	26-Mar-85	6303.6
WZ01	02-Apr-85	6303.4
WZ01	09-Apr-85	6303.5
WZ01	16-Apr-85	6303.6
WZ01	23-Apr-85	6303.9
WZ01	30-Apr-85	6304.1
WZ01	07-May-85	6304.2
WZ01	14-May-85	6304.5
WZ01	21-May-85	6304.6
WZ01	28-May-85	6304.8
WZ01	04-Jun-85	6305.0
WZ01	11-Jun-85	6304.9
WZ01	18-Jun-85	6305.0
WZ01	25-Jun-85	6305.5
WZ01	02-Jul-85	6305.2
WZ01	09-Jul-85	6305.5
WZ01	16-Jul-85	6305.4
WZ01	23-Jul-85	6305.5
WZ01	30-Jul-85	6305.7
WZ01	06-Aug-85	6305.7
WZ01	13-Aug-85	6305.7
WZ01	20-Aug-85	6305.8
WZ01	27-Aug-85	6305.6
WZ01	03-Sep-85	6305.6
WZ01	10-Sep-85	6305.4
WZ01	17-Sep-85	6305.2
WZ01	24-Sep-85	6309.4
WZ01	01-Oct-85	6310.9
WZ01	08-Oct-85	6311.3
WZ01	15-Oct-85	6310.4
WZ01	22-Oct-85	6310.3
WZ01	29-Oct-85	6309.6
WZ01	11-Nov-85	6308.8

collar elevation of 6,702 feet was used for head level calculation. The correct collar elevation is 6,075 feet. This data has now been corrected and is presented along with a time series plot (Figure 9-1a) of the head data.

Monitoring of streamflows has taken place in and around C-b Tract since 1974. Data for the two major stream gauging stations, 6007 which is located above C-b Tract on Piceance Creek and 6061 located below CB near Hunter Creek, are presented in Table-2. Again in 1985, as was the case in 1983 and 1984, streamflows are running above normal. Three consective wet years have accounted for high streamflow values. An annual mean of 53 CFS and daily maximum flow of

361 CFS were recorded at 6007. At 6061 even higher flows were recorded due to increased flows from the two major tributaries at CB of Stewart Gulch (6022) to the east and Willow Creek (6058) to the west. Gauge 6061 (Hunter Creek) recorded a daily maximum of 549 CFS with an annual mean of 71.2 CFS. Table 9-3 shows that at Stewart Gulch (Station 6022) an increase in flows to Piceance Creek from 2,666 acre-feet in 1984 to 4,960 in 1985. At Willow Creek (Station 6058) an additional increase from 4,666 in 1984 to 6,300 acre-feet was seen. In 1984 and 1985, even during the irrigation season, the minimum daily flows did not approach zero flow as was the case in some previous years. Daily minimum flows of 9.6 CFS (6007) and 19.0 CFS (6061) were recorded in 1985. Figures 9-2, a and b are histograms of precipitation at the Little Hills Station located in the northwestern part of the Piceance Basin and of Station 023 located on C-b Tract for a dry year (1980) and two wet years (1984 and 1985). Flows are also shown for the three Piceance Creek gauging stations 6007, 6061 and 6200 (Piceance Creek below Ryan Gulch) near C-b Tract which can then be compared to flow at the Major White River Station located below Meeker (Station 4800). Piceance Creek flow trends compare favorably with the White River flows.

Flows were recorded in Sorghum Gulch and West Stewart in water year 1985. Due to the three consecutive wet years (1983, 1984 and 1985) flow was observed in these washes. At Station 6036 at the mouth of Sorghum Gulch a total flow of 2.81 CFS was observed in March and 8.96 in April 1985. No flow numbers were recorded in West Stewart since stations WU25 and WU28 are no longer in service. These observations, however, help confirm the abnormally high Stewart Gulch 1985 flows.

V/E SHAFT WATER LEVEL

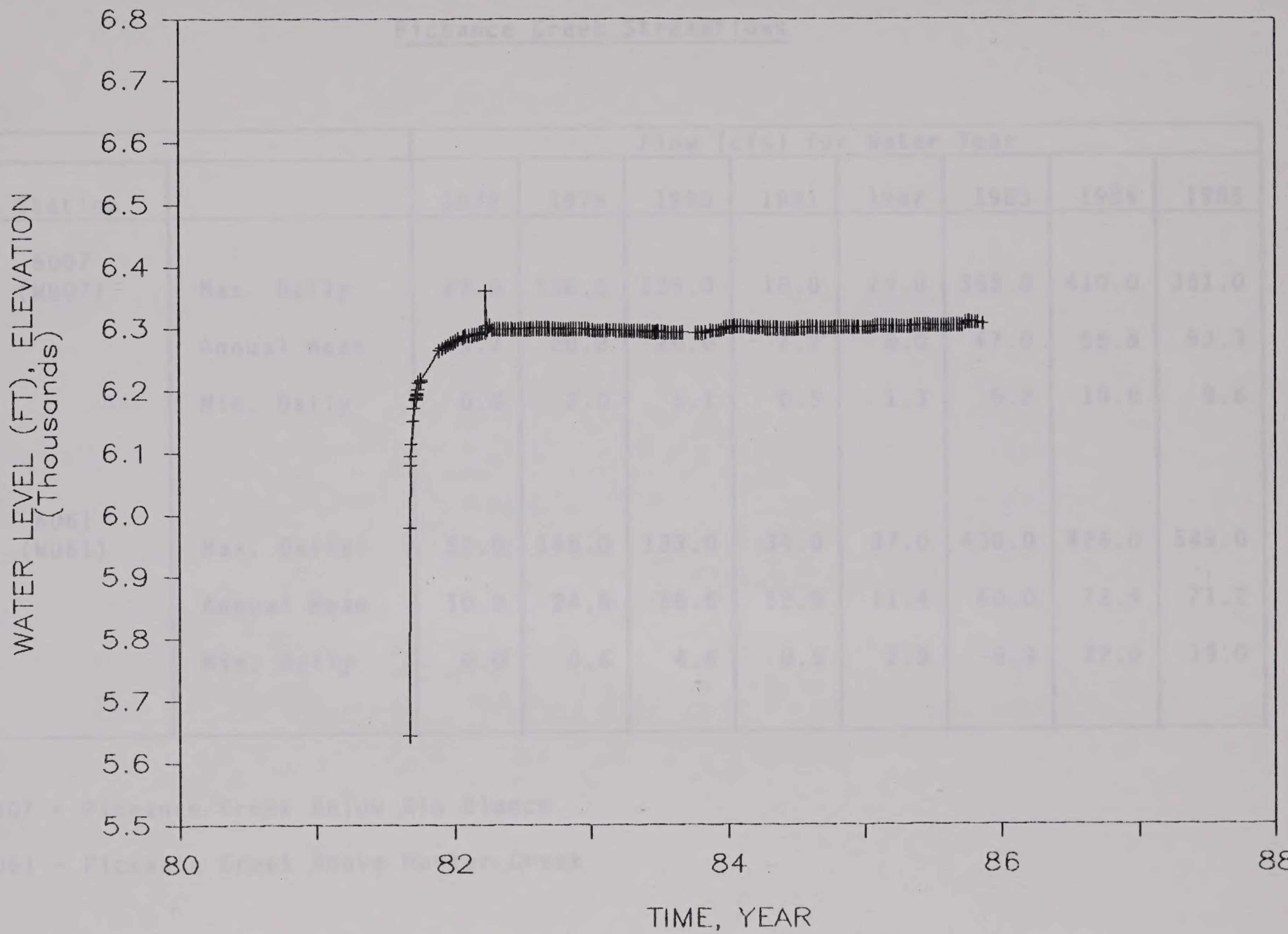


Figure 9-Ia V/E Shaft Water Level vs. Time

TABLE 9-2

Piceance Creek Streamflows

		Flow (cfs) for Water Year							
Station		1978	1979	1980	1981	1982	1983	1984	1985
6007 (WU07)	Max. Daily	83.0	158.0	135.0	18.0	29.0	365.0	410.0	361.0
	Annual Mean	9.7	20.8	20.0	7.2	8.0	47.0	55.8	53.3
	Min. Daily	0.6	2.0	5.1	0.5	1.3	5.2	10.0	9.6
6061 (WU61)	Max. Daily	52.0	149.0	133.0	34.0	37.0	430.0	426.0	549.0
	Annual Mean	10.9	24.6	25.6	12.9	11.4	60.0	72.5	71.2
	Min. Daily	0.0	0.6	4.6	0.5	2.9	8.9	22.0	19.0

6007 = Piceance Creek Below Rio Blanco

6061 = Piceance Creek Above Hunter Creek

TABLE 9-3

Annual Streamflows at Near -

Tract Tributaries to Piceance Creek

(ac-ft)

Water Year	Willow Creek (6058)	Stewart Gulch (6022)
1975	1437	1407
1976	1715	1933
1977	1008	999
1978	737	868
1979	820	898
1980	2891	1348
1981	1665	1203
1982	1043	1000
1983	2927	1739
1984	4666	2666
1985	6300	4960

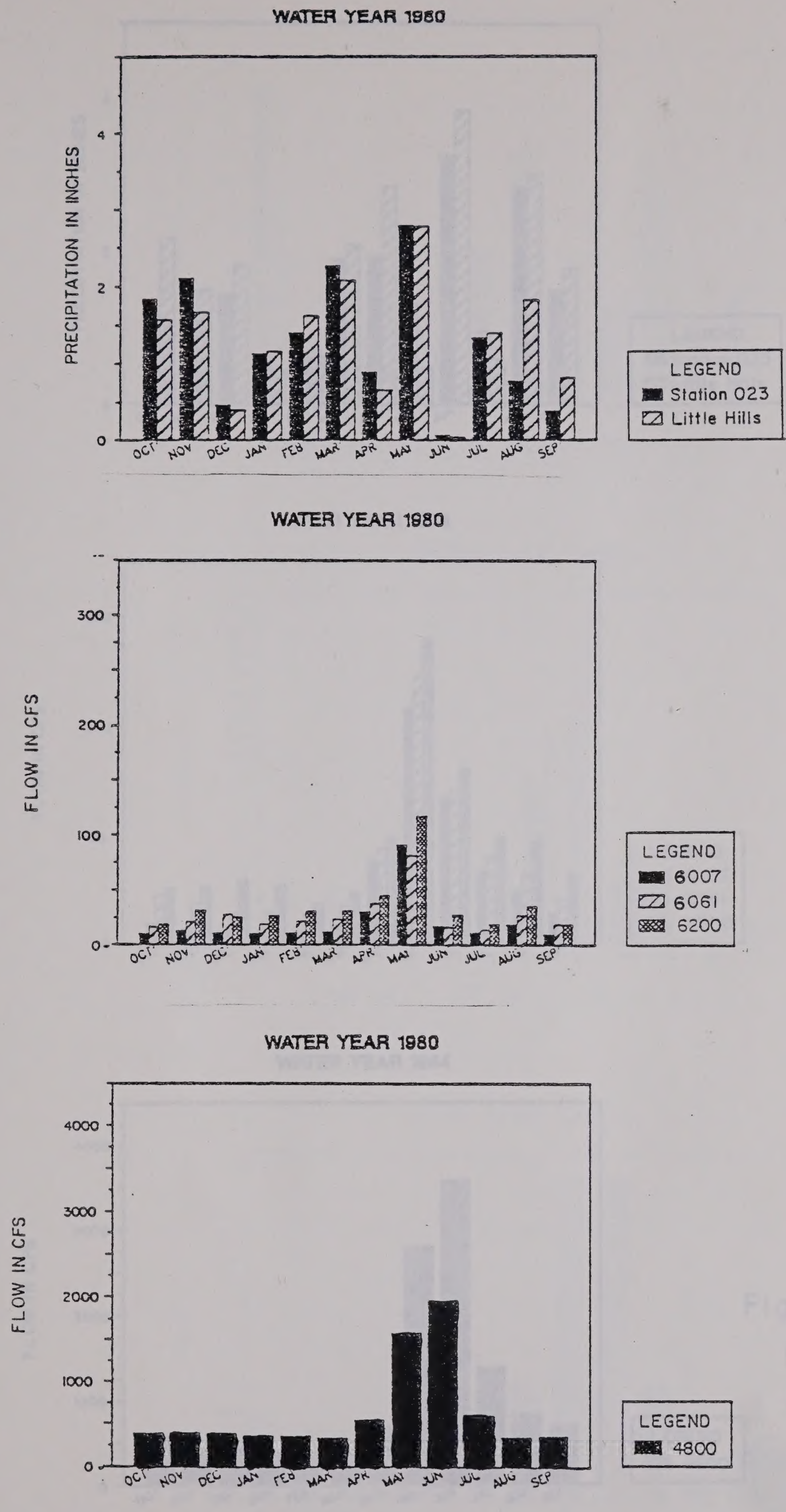
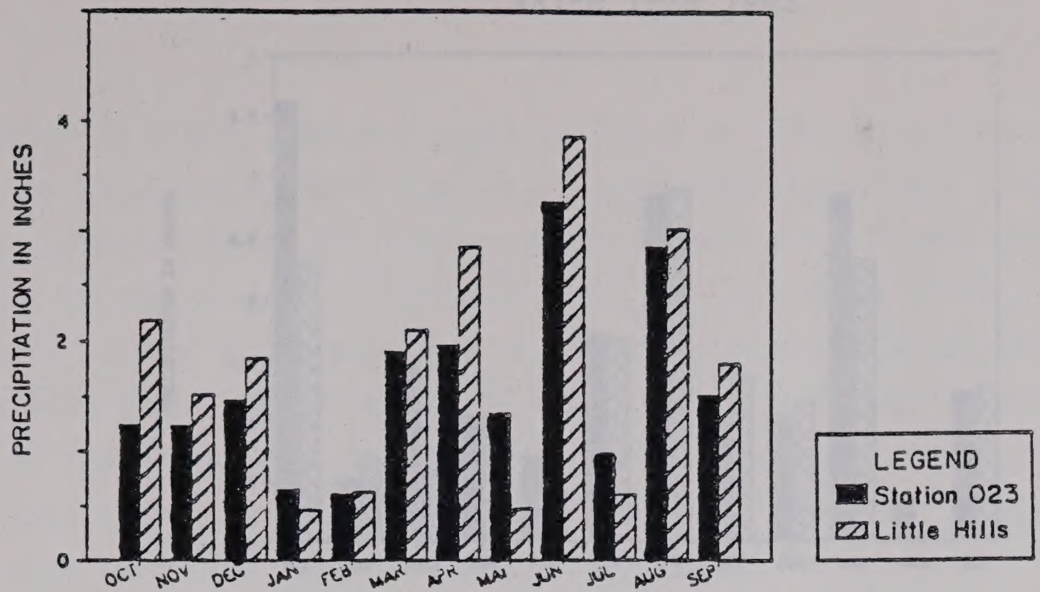
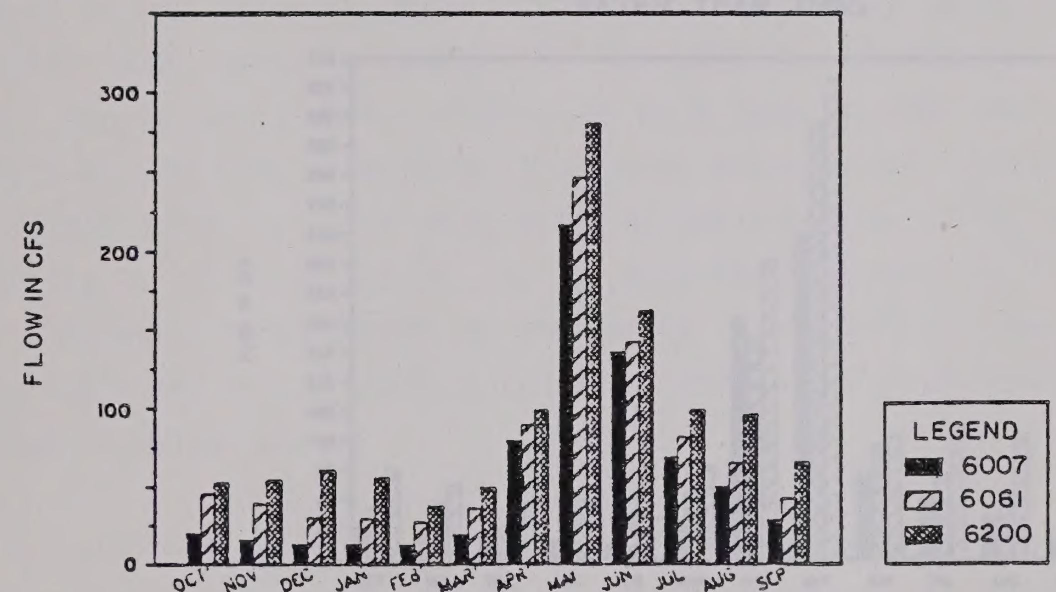


Figure 9-2

Precip. & Streamflow, 1980



WATER YEAR 1984



WATER YEAR 1984

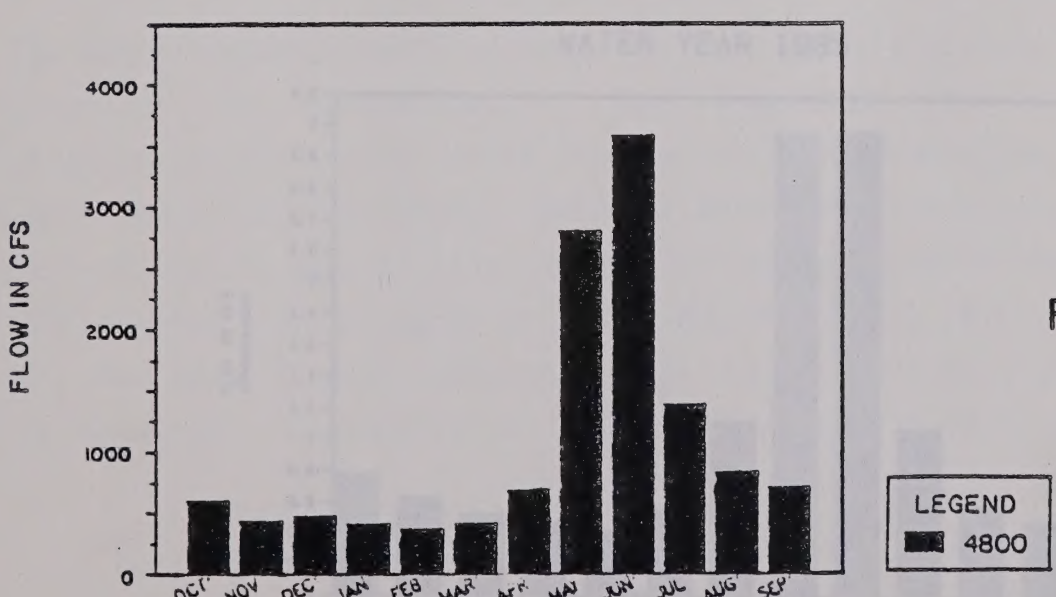


Figure 9-2a
Precip. &
Streamflow,
1984

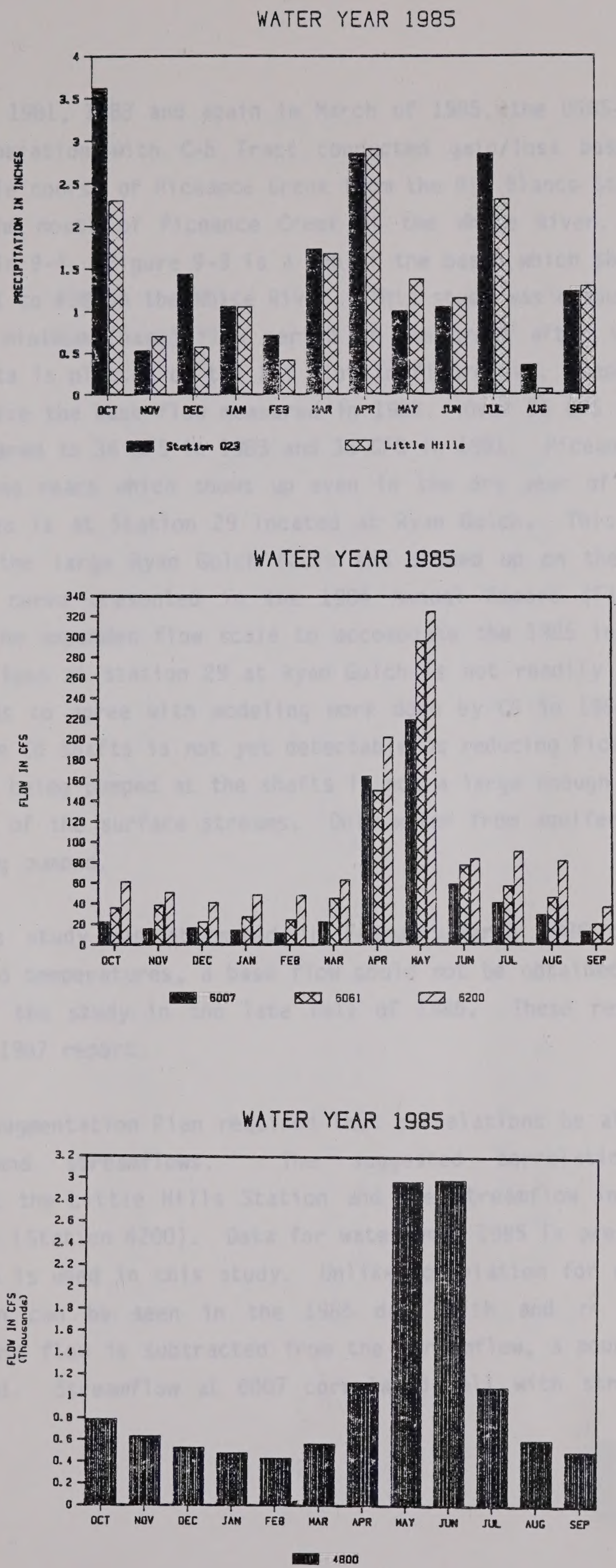


Figure 9-2b

Precip. & Streamflow, 1985

In March of 1981, 1983 and again in March of 1985, the USGS-WRD of Meeker, Colorado in cooperation with C-b Tract conducted gain/loss base flow studies along the 50 mile course of Piceance Creek from the Rio Blanco Store at Colorado Highway 13 to the mouth of Piceance Creek at the White River. This data is presented in Table 9-4. Figure 9-3 is a map of the basin which shows the station locations from #1 to #38 on the White River. This study was conducted as near as possible to the minimum (base) flow period of the creek after ice was off the stream. This data is plotted on the X-Y plot in Figure 9-4. Base flow for 1985 measured over twice the base flow measured in 1983. Over 95 CFS flowed into the White River compared to 36 CFS in 1983 and 35 CFS in 1981. Piceance Creek at C-b Tract is a gaining reach which shows up even in the dry year of 1981. A major A major loss area is at Station 29 located at Ryan Gulch. This is interesting since it is at the large Ryan Gulch fault and showed up on the 1981 and 1983 gain/loss study curve presented in the 1984 Annual Report (Figure 9-3, Page 9-10). Due to the expanded flow scale to accomodate the 1985 increased flow in Figure 9-4, the loss at station 29 at Ryan Gulch is not readily apparent. This data (1985) tends to agree with modeling work done by CB in 1984 and 1985 that dewatering at the CB shafts is not yet detectable as reducing Piceance Creek base flow. The water being pumped at the shafts is not a large enough volume to begin taking water out of the surface streams. Only water from aquifer storage and/or recharge is being pumped.

A gain/loss study was attempted in February/March 1986 but due to the unseasonably mild temperatures, a base flow could not be obtained. The decision was made to run the study in the late fall of 1986. These results should be reported in the 1987 report.

The Water Augmentation Plan required that correlations be attempted between precipitation and streamflows. The suggested correlation is between precipitation at the Little Hills Station and the streamflow in Piceance Creek below Ryan Gulch (Station 6200). Data for water year 1985 is presented in Tables 9-2 and 9-2B and is used in this study. Unlike correlation for water year 1984, some correlation can be seen in the 1985 data with and r^2 value of 0.59; however, when base flow is subtracted from the streamflow, a poor correlation of 0.19 is obtained. Streamflow at 6007 correlated well with streamflow at 6200

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TABLE 9-4
Gain/Loss Study Raw Data

Map Station Number	Stream Miles From White River	1981 Flow CFS	1983 Flow CFS	1985 Flow CFS
1	49.69	1.2	1.7	5.3
2	48.8	1.8	4.47	6.36
3	47.76	1.7	4.04	9.8
4	45.85	2.1	4.26	8
6	40.88	1.5	5.15	12.95
7	40.14	1.1	7.88	13.2
8	38.85	0.39	7.74	17.2
9	37.14	0.87	8.58	20.2
12	36.41	4.8	10.63	24
13	33.23	6.7	13.68	26.9
14	30.87	8	13.93	28.8
16	29.82	11.1	17.27	44.1
17	28.48	10.4	18.51	43.9
19	28.28	13	17.47	41.8
20	27.4	12.6	18.94	42.7
22	25.43	16.7	19.84	45.3
24	24.88	18.6	22.2	60.6
25	22.53	19.6	30.98	--
27	20.8	23.6	32.94	75
28	19.67	25.1	32.94	78.1
29	18.1	23.8	33.39	69
30	15.59	25.4	32.56	71.7
31	13.71	25.4	32.23	85.1
32	12.12	26.3	32.72	80.4
33	9.04	26.3	34.74	86.2
35	5.92	31.7	38.01	88.4
36	4.03	31.2	36.83	98.3
37	1.32	34.7	40	93.1
38	0.26	35.2	37.5	95.4

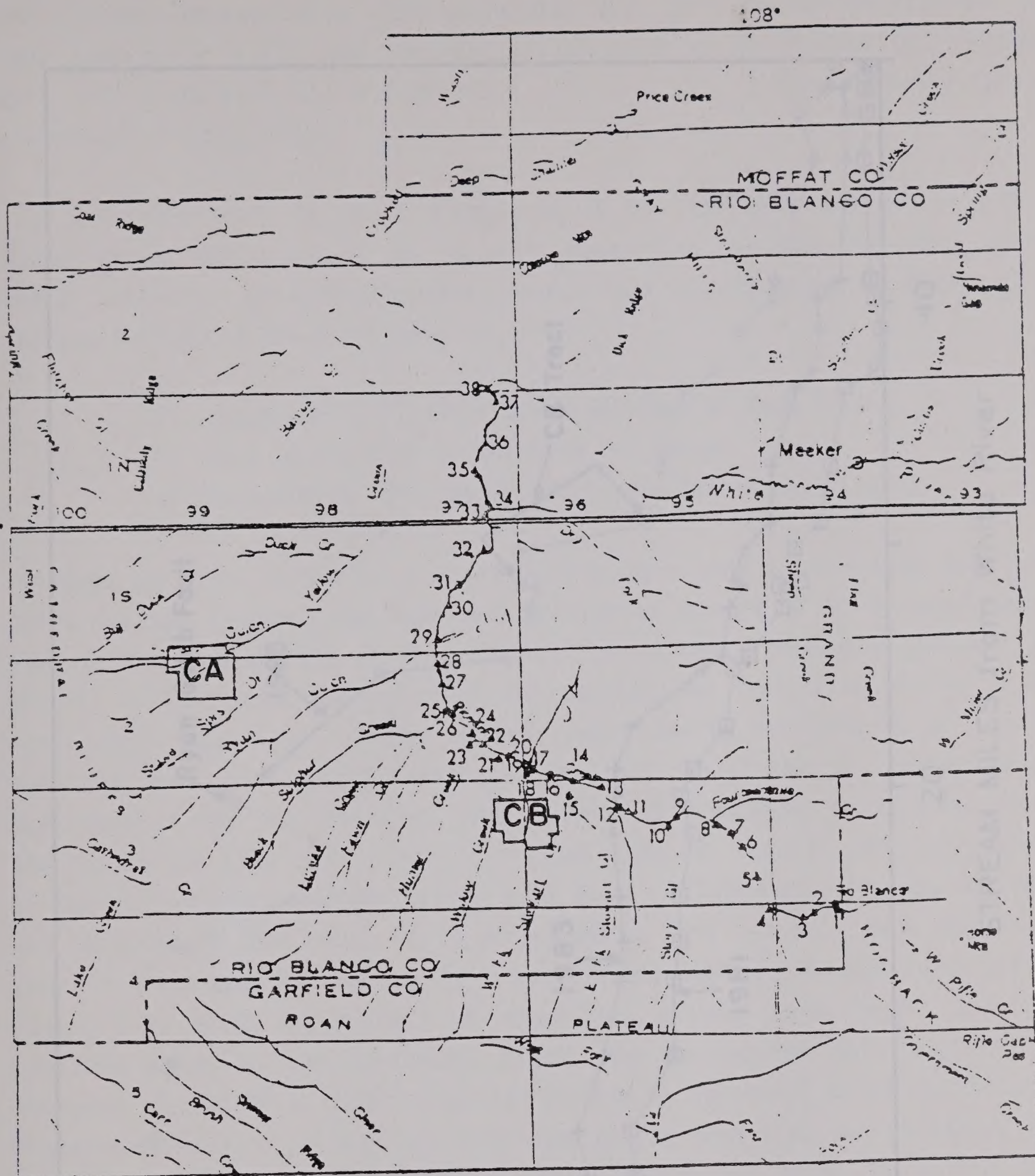

Figure 9-3 Piceance Creek Gain/Loss Study Measurement Sites

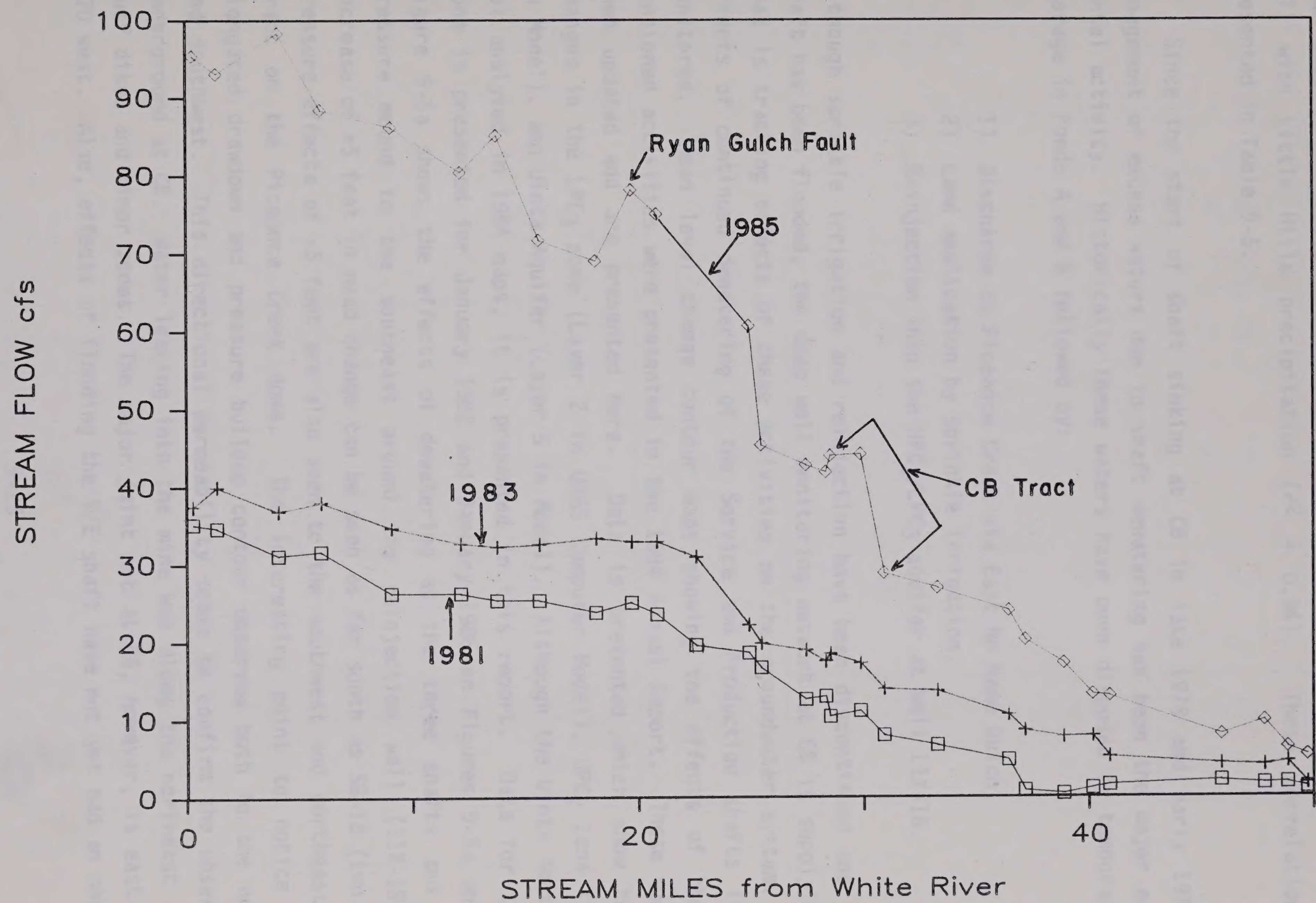

Figure 9-4 Piceance Creek Gain/Loss Study; March 1981, 1983, & 1985

(r^2 = 0.97); streamflow at 6200 correlated well with streamflow data for water year 1980 (r^2 = 0.93); and monthly precipitation at CB Station 023 correlated well with Little Hills precipitation (r^2 = 0.94). These correlations are presented in Table 9-5.

Since the start of shaft sinking at CB in late 1978 and early 1979, the management of excess waters due to shaft dewatering has been the major environmental activity. Historically these waters have been disposed by temporary pond storage in Ponds A and B followed by:

1) Discharge to Piceance Creek via East No Name Gulch.
2) Land application by sprinkle irrigation.
3) Reinjection into the UPC_2/LPC_3 aquifer at Well 11X-18.

Although sprinkle irrigation and reinjection have been discontinued and the V/E shaft has been flooded, the deep well monitoring network at CB is supplying data that is tracking effects of these activities on the groundwater system. Also, effects of continued dewatering of the Service and Production shafts is being monitored. Head level change contour maps showing the effects of the above mentioned activities were presented in the 1984 Annual Report. These maps have been updated and are presented here. Data is presented which show the head changes in the LPC_3 zone (Layer 2 in USGS Computer Model), UPC_2 Zone (Layer 4 in Model), and Uinta Aquifer (Layer 5 in Model). Although the Uinta Aquifer was not analyzed in 1984 maps, it is presented in this report. Data for the LPC_3 zone is presented for January 1982 and January 1986 on Figures 9-5a and 9-5b. Figure 9-5a shows the effects of dewatering at the three shafts and also a pressure mound to the southeast around the reinjection well (11X-18). An increase of +5 feet in head change can be seen as far south as SG-18 (two miles). Pressure effects of -5 feet are also seen to the southwest and northeast of C-b tract on the Piceance Creek dome. The interesting point to notice is the elongated drawdown and pressure buildup contour observed both to the northeast and southwest. This directional permeability seems to confirm the observations underground at CB. Water leaking into the mine was along the northeast trending tuff dikes and minor zones. The major joint set at CB, however, is east-west to W70 west. Also, effects of flooding the V/E shaft have not yet had an observable

(r^2 = 0.97); streamflow at 0200 correlated well with streamflow data for water year 1983 (r^2 = 0.93); and monthly precipitation at CB Station 023 correlated well with Little Hills precipitation (r^2 = 0.94). These correlations are presented in Table 9-5.

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TABLE 9-5

Precipitation and Streamflow Regressions

Variable x	Variable y	Data Set	No. of Sample Pairs	Regression Constants		
				a	b	r^2
Monthly Precip. @ C-b Sta. 023 (in.)	Monthly Precip. @ Little Hills (in.)	Water Yr. 1985	12	0.06	0.82	0.94
Monthly Precip. @ Little Hills (in.)	Monthly Avg. Streamflow @ Sta. 6200 (cfs)	Water Yr. 1985	12	13.76	61.97	0.59
Monthly Precip. @ Little Hills (in.)	Mo. Avg. Stream-flow @ Sta. 6200 (cfs)Less Base-flow	Water Yr. 1985	12	-5.11	24.25	0.19
Mo. Avg. Stream-flow @ Sta. 6007 (cfs)	Mo. Avg. Stream-flow @ Sta. 6200 (cfs)	Water Yr. 1985	12	30.4	1.24	0.97
Mo. Avg. Stream-flow @ Sta. 6200 (cfs) - Yr. 1980	Mo. Avg. Stream-flow @ Sta. 6200 (cfs) - Yr. 1985	Water Yrs. 1980, 1985	12	-1.99	2.78	0.93

Regression: $y = a + bx$
r^2 = Coefficient of Determination

Station 6200 = Piceance Creek @ Ryan Gulch; Station 6007 = Piceance Creek @ Stewart Gulch

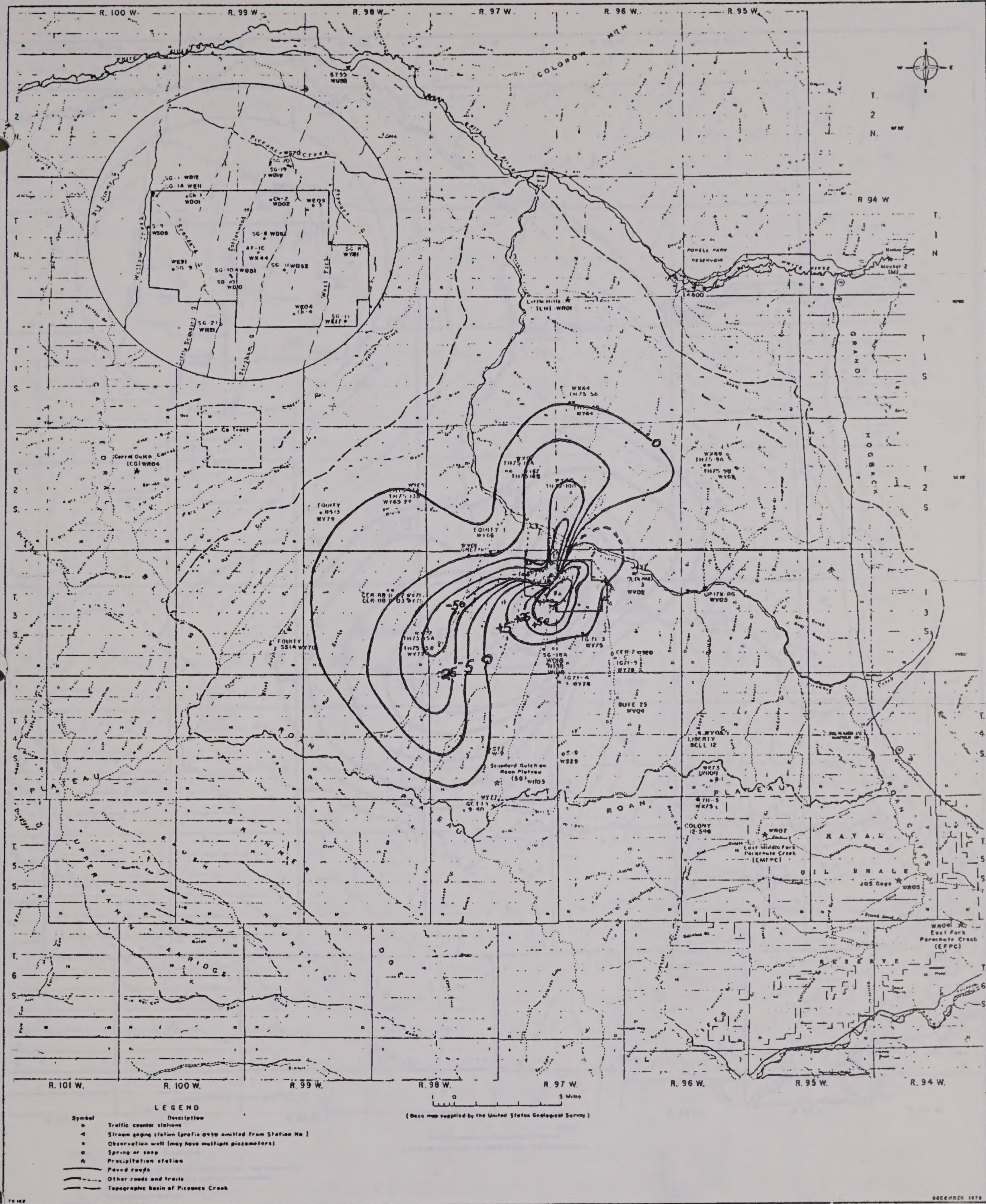

Figure 9-5a Head Change in the LPC3 Zone (Layer 2) January 1982

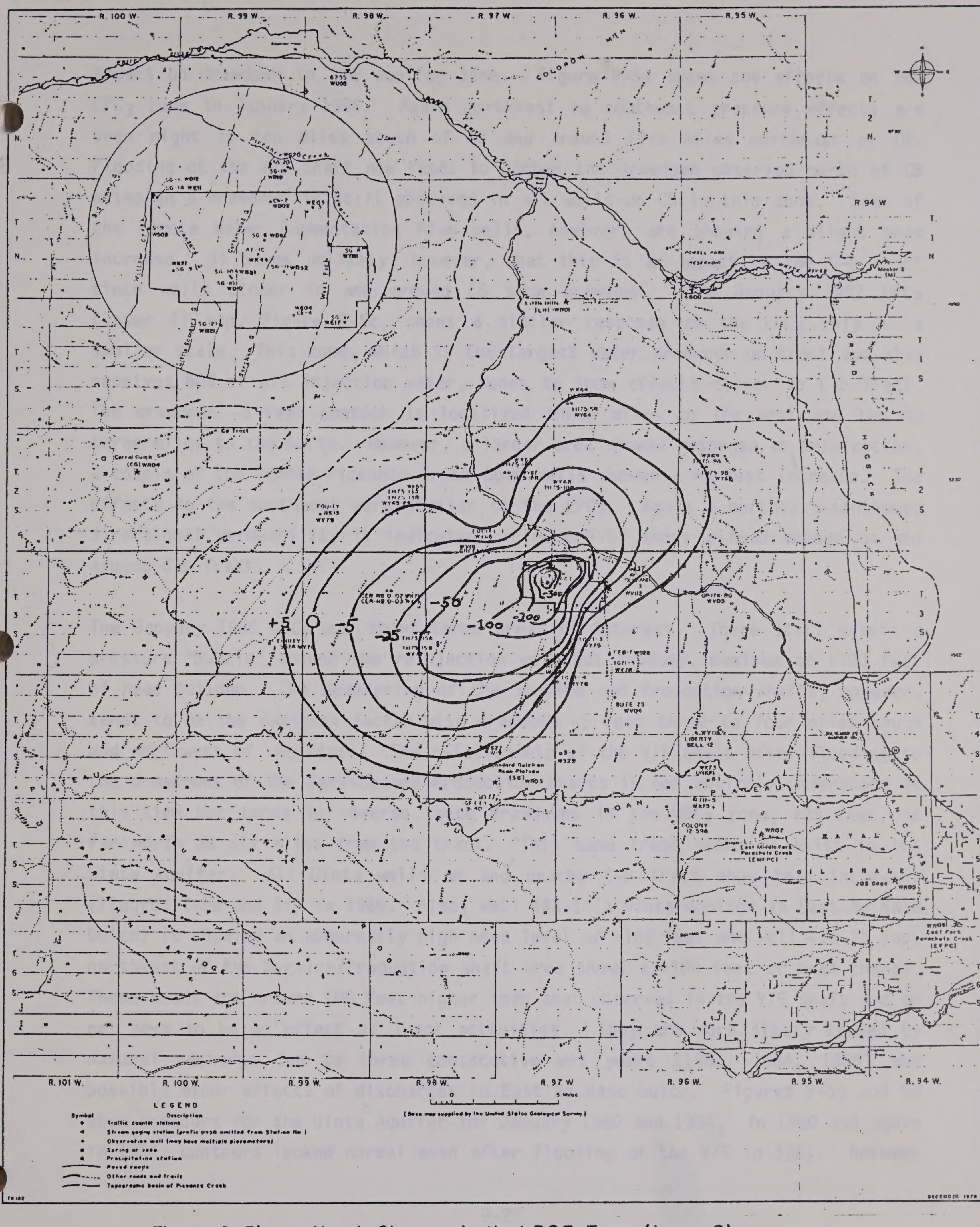

Figure 9-5b Head Change in the LPC3 Zone (Layer 2)

January 1986

impact on drawdown in the aquifer zone. Figure 9-5a shows the effects on the LPC_3 zone in January 1986. Again northeast to southwest pressure effects are seen eight to ten miles south of CB and around five miles northeast of CB. Flooding of the V/E shaft now tends to dampen the drawdown observed north of CB although a drawdown is still observed in all wells on CB in this zone. Some of the remote Water Augmentation Plan wells, however, are showing a slight head increase. It seems unlikely, however, that this is an impact on the C-b tract since wells closer in and around CB show drawdown. The January 1982 UPC_2 (Layer 4) map, Figure 9-5c, shows a similar response as the LPC_3 only on a smaller scale. This zone, which is the largest water producer on tract and also receives 60% of all injection water, tends to show effects closer to C-b Tract. The drawdown -5 feet contour is localized three miles to the west and two to three miles to the north. However, a larger area showed response to reinjection, a couple of the remote Piceance Creek Dome wells showed a +5 feet increase. The effects to the southwest were similar to the LPC_3. Again a northeast-southwest directional permeability is indicated. Figure 9-5d shows a head change on and around C-b Tract.

The January 1986 UPC_2 map shows three areas of interest. There still exists a pressure "bubble" around the reinjection well but subdued, maximum of +100 feet of head buildup. The dewatering of the Service and Production shafts, however, tends to be the dominant factor with drawdown -5 feet three to four miles south and northwest of the tract. The relationship of the V/E shaft after flooding to the drawdowns of the Service and Production shafts is not entirely understood at this time but tends to reverse these drawdowns in the UPC_2 zone, +25 feet, as far north as six miles from the tract. This same trend seems to exist in the Uinta Aquifer. All Uinta wells on and nearby C-b Tract show head increases (Figures 9-5e and 5f) in 1986. Also, Well 44X-1 (a Uinta monitor in East No Name Gulch) is showing an abnormally high head level of +168 feet and Well 41X-12 just northeast of the Service/Production shaft area shows a +100 feet of head change. These heads are around 200 feet higher than that observed in the V/E shaft and do not seem to be an effect of Tract activities. They are more likely caused by natural recharge due to three consecutive wet years (1983, 1984, 1985) and possible minor effects of discharges to East No Name Gulch. Figures 9-5g and 5h show contours for the Uinta Aquifer for January 1980 and 1984. In 1980 and again in 1984, contours looked normal even after flooding of the V/E in 1981. Between

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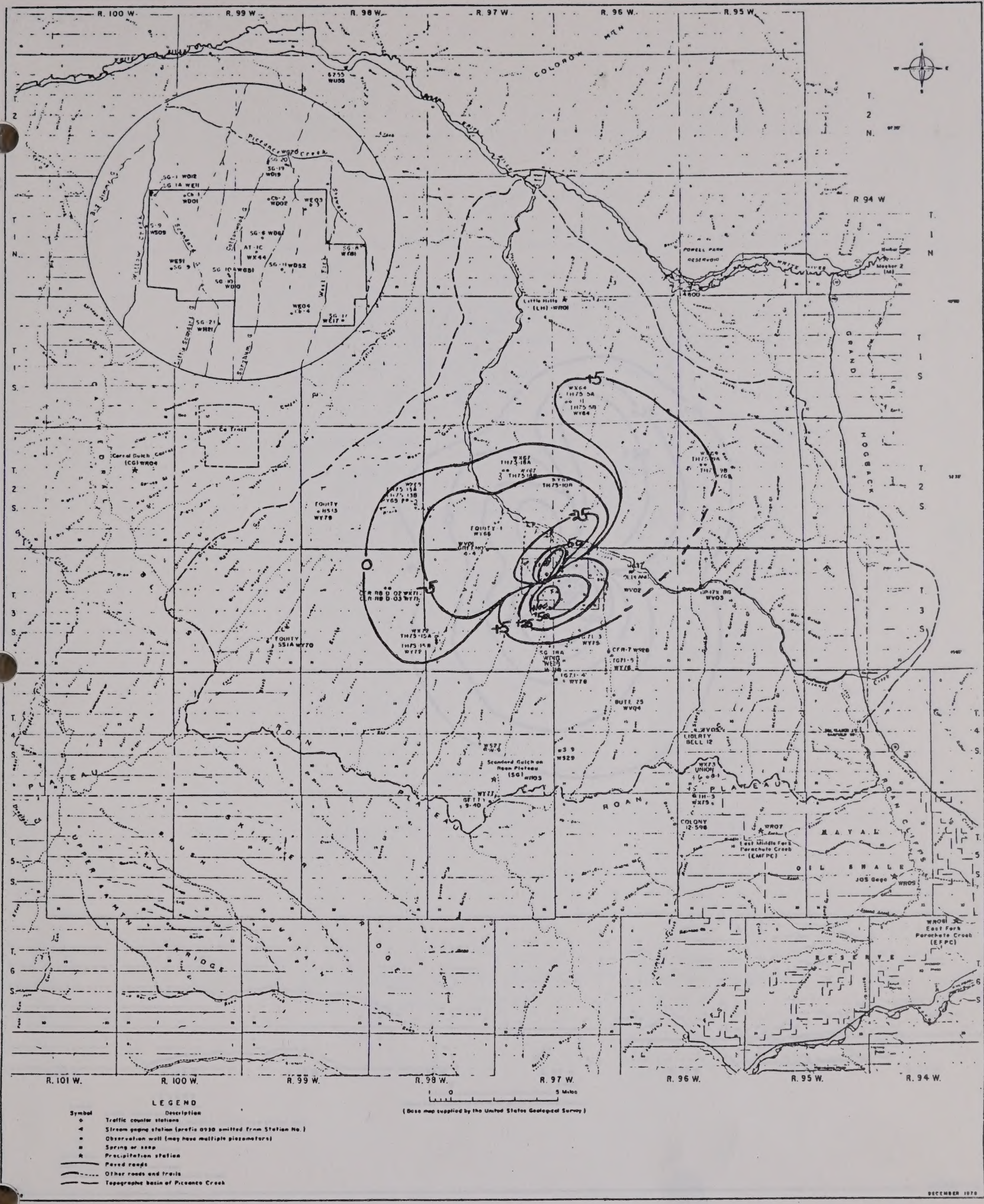

Figure 9-5c Head Change in the UPC2 Zone (Layer 4)

January 1982

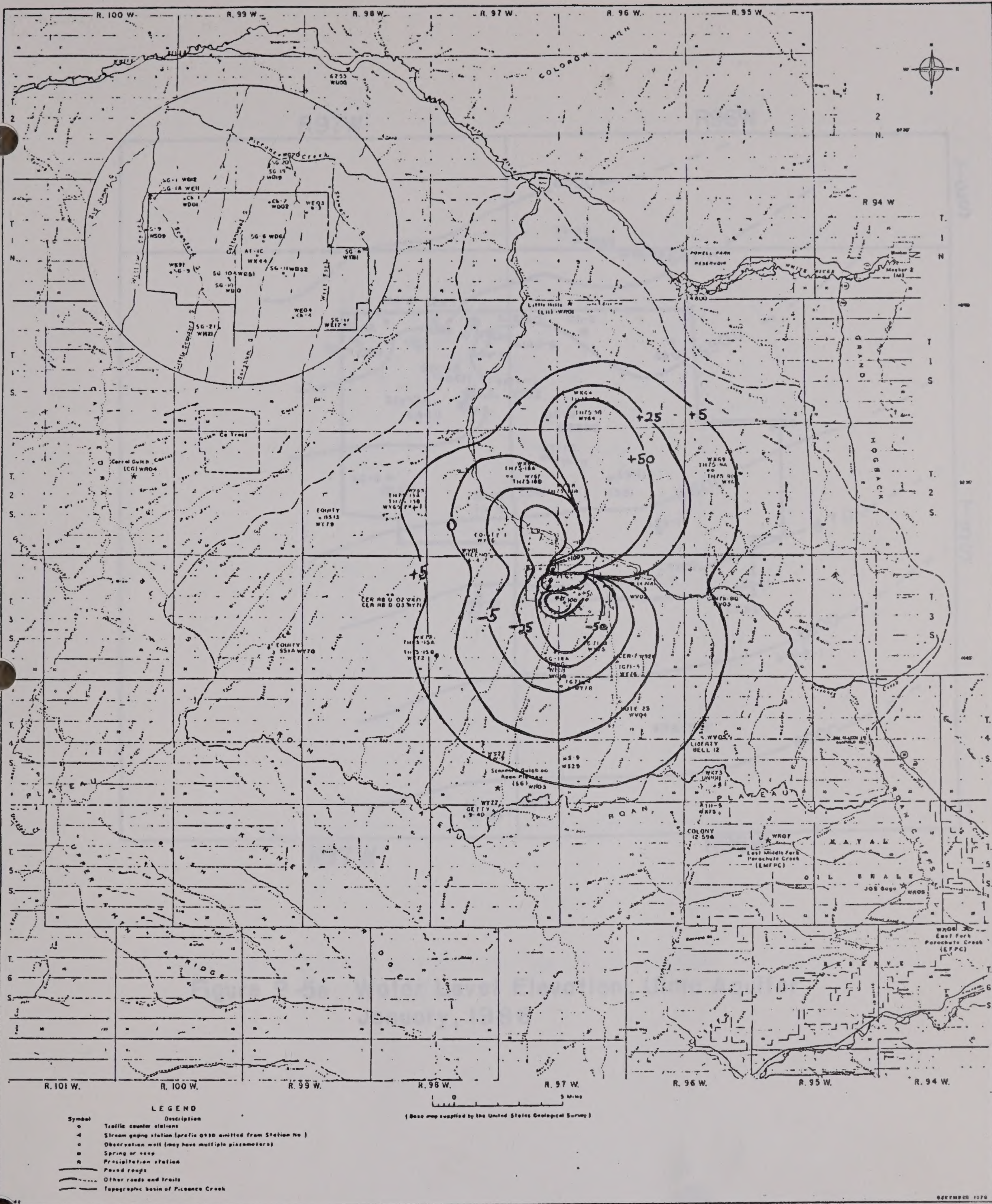

Figure 9-5d Head Change in the UPC2 Aquifer Zone (Layer 4)

January, 1986

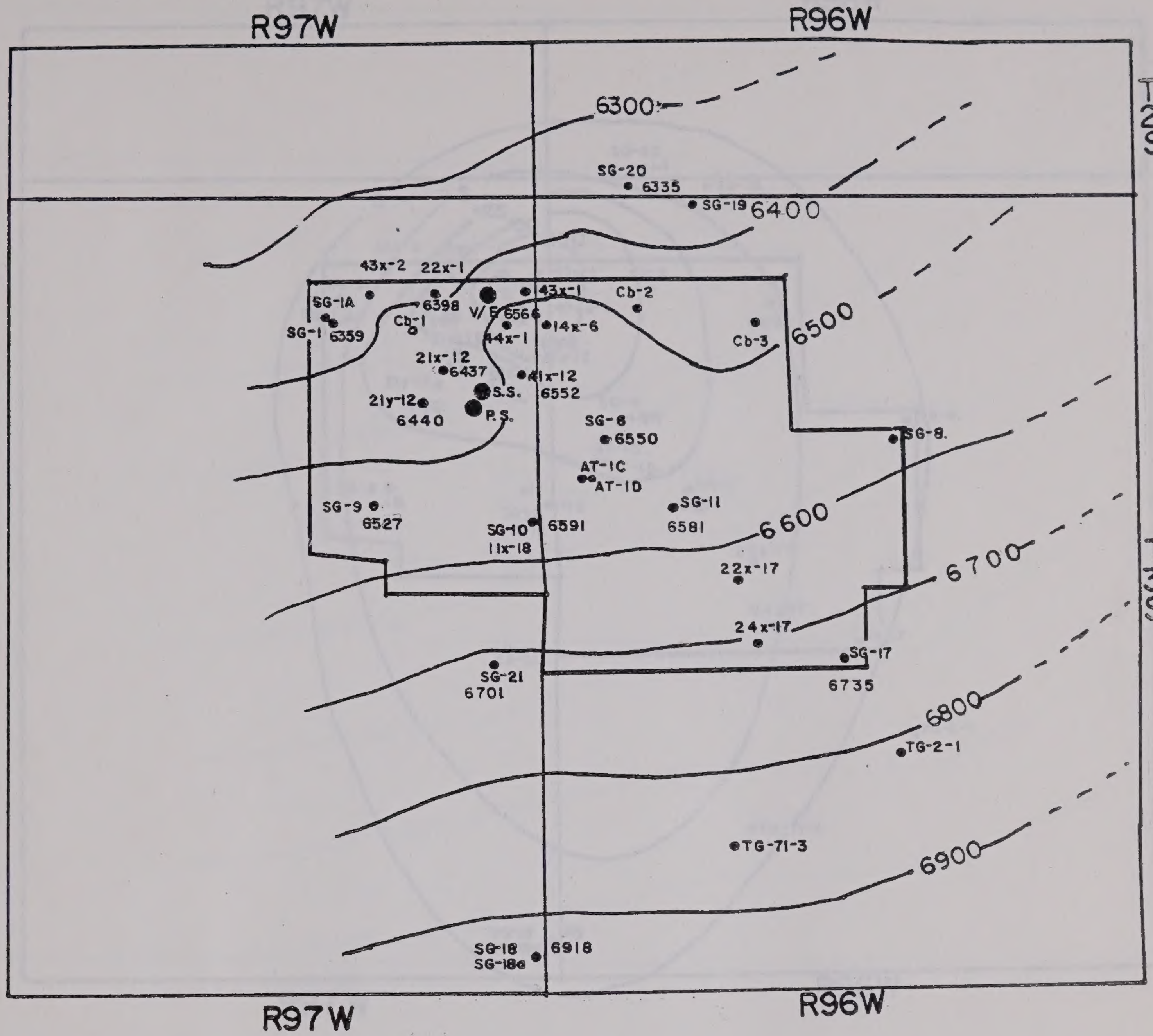

Figure 9-5e Water Level Elevation, Uinta Aquifer January, 1986

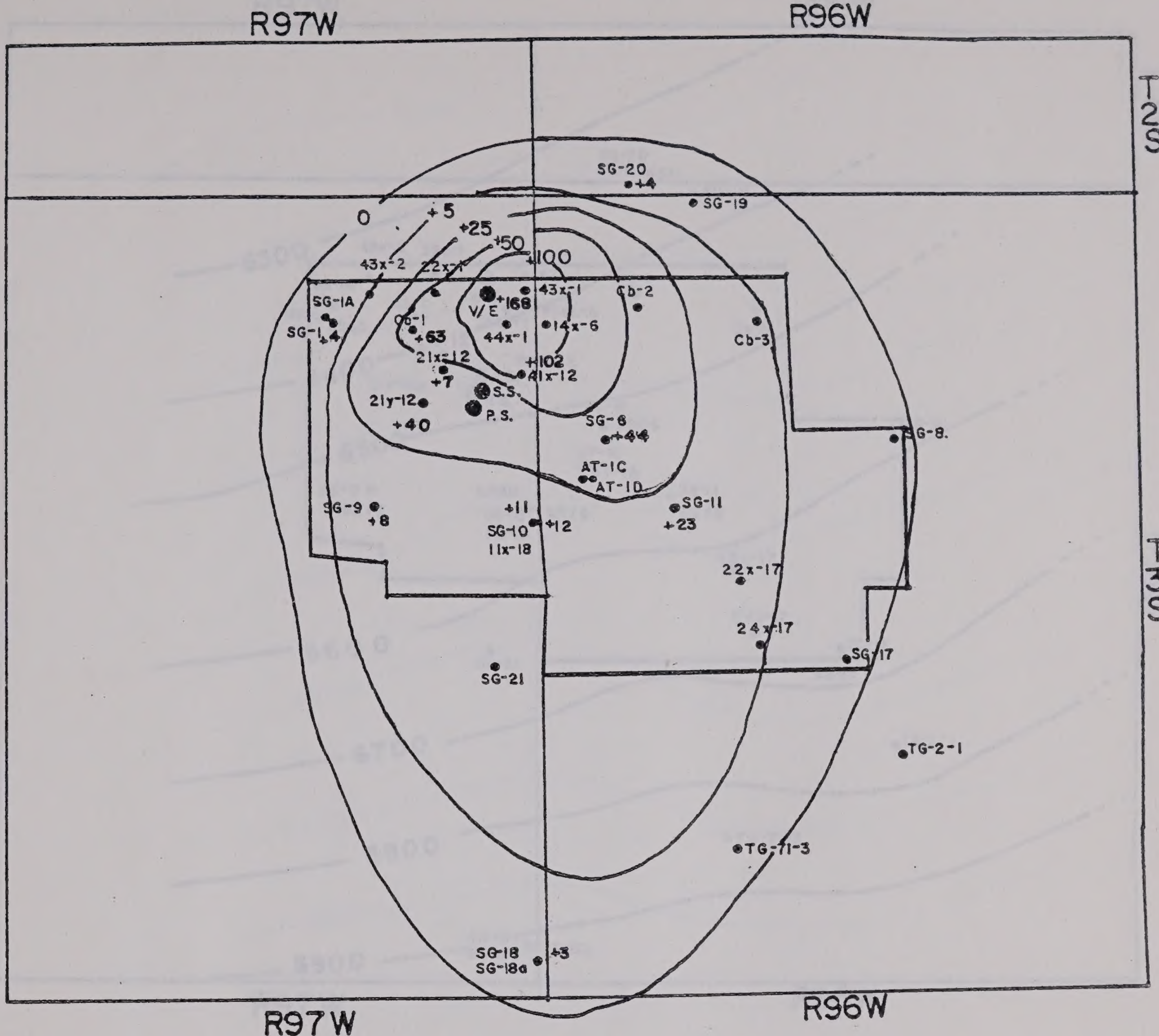

Figure 9-5f Change in Head for the Uinta Aquifer
January, 1986

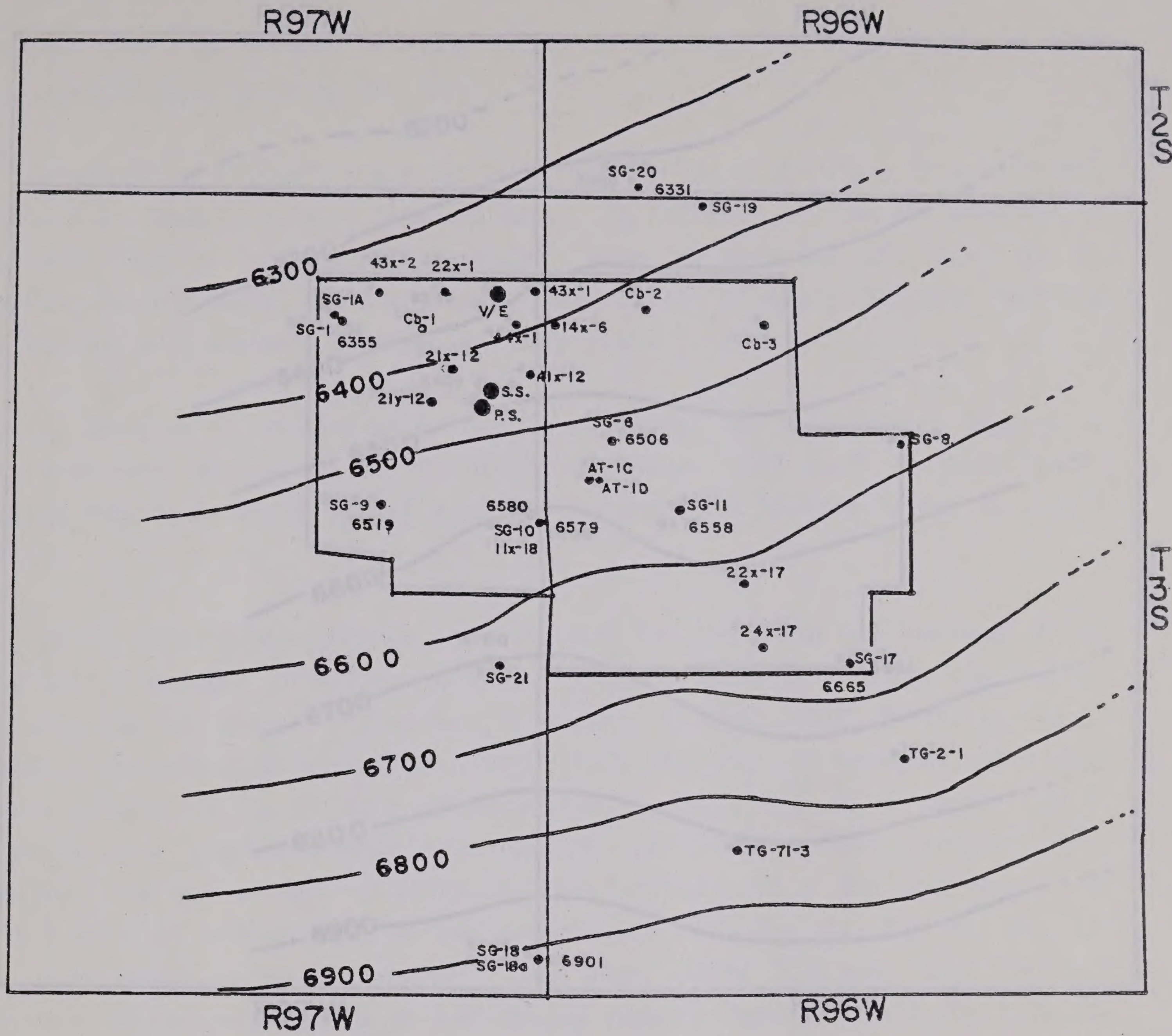

Figure 9-5g Water Level Elevation, Uinta Aquifer January, 1980

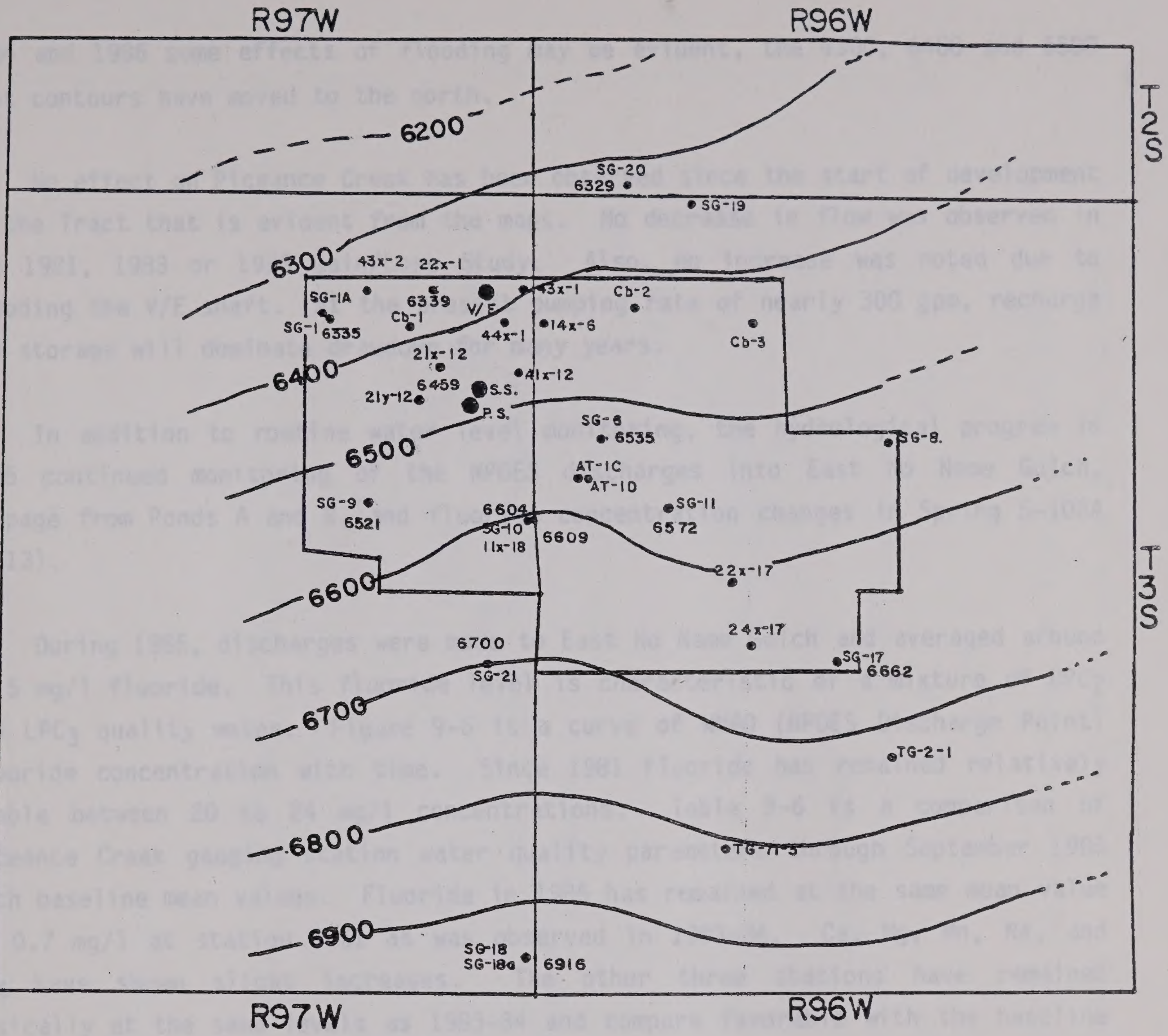

Figure 9-5h Water Level Elevation, Uinta Aquifer
January, 1984

1984 and 1986 some effects of flooding may be evident, the 6300, 6400 and 6500 foot contours have moved to the north.

No effect on Piceance Creek has been observed since the start of development of the Tract that is evident from the maps. No decrease in flow was observed in the 1981, 1983 or 1985 Gain/Loss Study. Also, no increase was noted due to flooding the V/E shaft. At the present pumping rate of nearly 300 gpm, recharge and storage will dominate drawdown for many years.

In addition to routine water level monitoring, the hydrological program in 1985 continued monitoring of the NPDES discharges into East No Name Gulch, seepage from Ponds A and B, and fluoride concentration changes in Spring S-102A (WS13).

During 1985, discharges were made to East No Name Gulch and averaged around 22.5 mg/l fluoride. This fluoride level is characteristic of a mixture of UPC_2 and LPC_3 quality water. Figure 9-6 is a curve of WN40 (NPDES Discharge Point) fluoride concentration with time. Since 1981 fluoride has remained relatively stable between 20 to 24 mg/l concentrations. Table 9-6 is a comparison of Piceance Creek gauging station water quality parameters through September 1985 with baseline mean values. Fluoride in 1985 has remained at the same mean value of 0.7 mg/l at station 6061 as was observed in 1983-84. Ca, Mg, Mn, Na, and SO_4 have shown slight increases. The other three stations have remained basically at the same levels as 1983-84 and compare favorable with the baseline data.

Holding ponds (A and B) were checked for seepage again by comparing key water quality parameters with those of its downdip seepage monitoring well (Table 9-7). Fluoride concentration in the seepage well has remained relatively constant during 1985 as has the sodium and calcium concentrations. No unexpected changes in water quality have been observed during 1985.

No water quality samples were taken during 1985 for alluvial wells at C-b Tract. Springs that were sampled for field parameters showed no significant trends in 1985. Spring S102A, however, was monitored for field parameters on a quarterly basis due to its strategic location near CB's discharge point at the

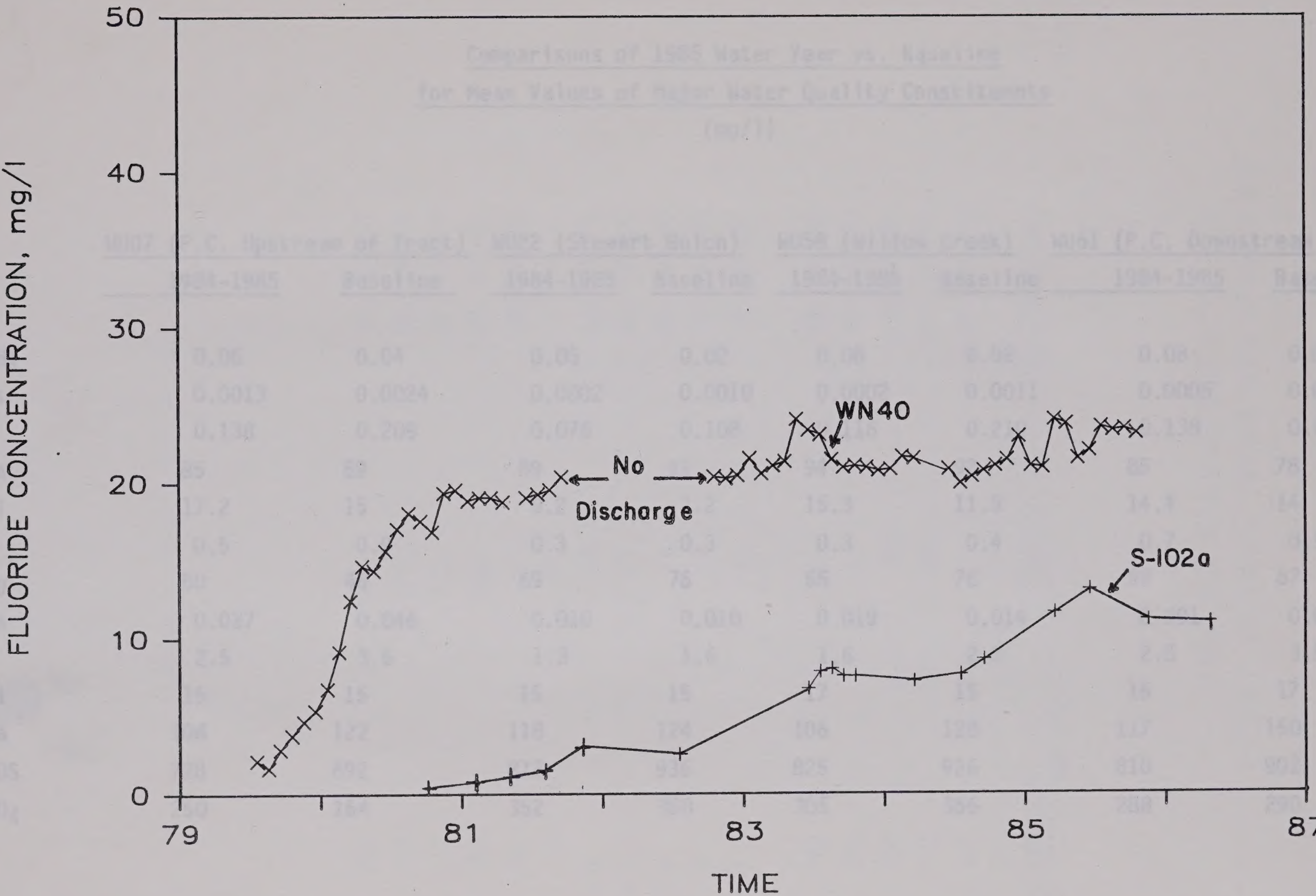

Figure 9-6 Fluoride Concentration vs. Time for WN40 NPDES Discharge Point and for Spring S-102A

TABLE 9-6

Comparisons of 1985 Water Year vs. Baseline
for Mean Values of Major Water Quality Constituents
(mg/1)

	WU07 (P.C. Upstream of Tract)		WU22 (Stewart Gulch)		WU58 (Willow Creek)		WU61 (P.C. Downstream of Tract)	
	1984-1985	Baseline	1984-1985	Baseline	1984-1985	Baseline	1984-1985	Baseline
NH_3	0.06	0.04	0.05	0.02	0.06	0.02	0.08	0.03
As	0.0013	0.0024	0.0002	0.0010	0.0002	0.0011	0.0005	0.0023
B	0.138	0.209	0.076	0.108	0.116	0.210	0.138	0.214
Ca	85	69	89	93	94	92	85	78
Cl	17.2	15	9.2	7.2	15.3	11.5	14.4	14
F	0.5	0.9	0.3	0.3	0.3	0.4	0.7	0.9
Mg	50	46	69	76	65	76	59	67
Mn	0.027	0.046	0.010	0.010	0.019	0.014	0.291	0.066
K	2.5	3.6	1.3	1.6	1.6	2.2	2.5	3.5
Si	15	15	15	15	17	15	15	17
Na	106	122	118	124	106	128	117	150
TDS	728	692	872	936	825	926	810	902
SO_4	250	164	352	368	305	356	288	290

Station values in 1984-1985 are for the months of 10/84 thru 9/85 (i.e. WY 1985) from USGS water data.
Baseline values are for the period 11/74 to 10/76 - from environmental baseline program.

TABLE 9-7

Comparison of Water Quality in Pond A/B (WN40) with its Seepage Monitoring Well (WW22)

Water Quality Parameter	Sampling Date	Value (mg/l) Pond	Seepage Well
Na	Spring '81	-	170
	Spring '82	540	250
	Spring '83	610	260
	Spring '84	-	280
	Spring '85	470	290
F	Spring '81	19	1.5
	Spring '82	22	0.7
	Spring '83	21	0.3
	Spring '84	23	0.4
	Spring '85	20	0.5
Ca	Spring '81	-	98
	Spring '82	5.2	150
	Spring '83	7.1	230
	Spring '84	5.0	200
	Spring '85	5.9	220

mouth of No Name Gulch. Figure 9-6 is an up-to-date comparison (through March 1986) of fluoride concentration with time versus NPDES discharge concentrations. The latest data shows a slight downward trend from a peak concentration of 15 mg/l in mid-1985 to the present value of 11 mg/l. As stated in the 1984 Annual Report, Spring S102A is responding to CB's discharges; however, flow volume of the spring has remained relatively constant since measurements were initiated in 1980. Spring S102A will be closely monitored in the future to observe any possible water quality trends.

The only deep wells sampled during 1985 were the recompleted wells during September and October. After the wells were completed, a swabbing unit was used to cleanup each well. Around 10 to 15 swabs were taken per well or until the conductivity became stable. These samples are presented in Table 9-8. This table has the wells grouped as to aquifer unit. The single LPC_4 well (SG-21-1) shows typical lower aquifer high bicarbonate water (2,290 mg/l bicarbonate), high sodium (1,390 mg/l), TDS (3,400 mg/l), and fluoride (22.7 mg/l). Only well SG-20-1 reflects typical LPC_3 water quality values for fluoride (21.6 mg/l), bicarbonate (1,420 mg/l), boron (1.16 mg/l), and sodium (736 mg/l). The other three wells tend to reflect UPC_2 water qualities and SG-11-1 has a fluoride level of 0.15 mg/l and sulfate level of 718 mg/l, typical of Uinta water.

The UPC_2 wells, except for SG-11-2 and SG-20-2, are typical UPC_2 water qualities. SG-11-2 again is close to Uinta water quality whereas SG-20-2 has LPC_3 or LPC_4 fluoride values (24.6 mg/l), bicarbonate (1,500 mg/l), sodium (709 mg/l), boron (1.3 mg/l), and TDS (1,700 mg/l). SG-20-3 also has typical lower aquifer quality of high fluoride (19.1 mg/l) and low sulfate (21 mg/l). The Unita wells reflect good completions based on their fluoride and sulfate values. Fluoride is very low (0.13 to 1.60 mg/l) and sulfate is high at 308 to 1,150 mg/l with an average of 590 mg/l.

9.3.4 Aquatic Biology

The purpose is to summarize benthic macroinvertebrate and periphyton communities in Piceance Creek around C-b Tract and to evaluate the effects of C-b's activities on the aquatic system. Data tables will appear in the 6-month data report.

mouth of No Name Gulch. Figure 9-6 is an up-to-date comparison (through March 1986) of fluoride concentration with time versus NPDES discharge concentrations. The latest data shows a slight downward trend from a peak concentration of 15 mg/l in mid-1985 to the present value of 11 mg/l. As stated in the 1984 Annual Report, Spring S102A is responding to C-b's discharges; however, flow volume of the spring has remained relatively constant since measurements were initiated in 1980. Spring S102A will be closely monitored in the future to observe any possible water quality trends.

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Table 9-8

Water Quality of Recompleted Wells

1985

WELL NUMBER	AQUIFER UNIT	WATER QUALITY PARAMETER (MG/L)											
		Bicarb	B	Ca	Cl^-	Cu	Fl^-	Pb	K	Na	TDS	S04	Zn
SG-21-1	LPC_4	2290	0.62	<1	34	2.91	22.7	14.7	3	1390	3400	101	14.4
SG-20-1	LPC_3	1420	1.16	1	19	2.41	21.6	15.6	2	736	1650	4	20.4
SG-11-1	LPC_3	452	0.07	105	14	3.37	0.15	9.99	1	195	1400	718	17.6
SG-21-2	LPC_3	396	0.28	2	4	1.17	14.7	5.28	1	194	526	23	5.69
SG-18A-1	LPC_3	443	0.32	15	18	0.46	10.8	0.69	<1	214	582	74	1.75
SG-18A-2	UPC_2	374	0.29	14	41	0.54	7.98	1.74	4	230	580	99	2.21
SG-11-2	UPC_2	497	0.08	109	11	0.32	0.19	0.51	1	197	1460	743	0.81
SG-21-3	UPC_2	481	0.28	4	4	0.50	14.0	0.93	<1	206	512	29	4.29
SG-20-2	UPC_2	1500	1.30	1	23	0.36	24.6	0.24	2	709	1700	4	0.56
22X-17	UPC_2	295	0.49	23	52	0.08	15.1	0.21	<1	280	836	533	0.59
24X-17	UPC_2	470	0.51	19	19	<0.02	14.3	0.09	<1	314	810	323	1.13
SG-20-3	UPC_1/Uinta	1500	0.98	1	12	0.18	19.1	0.66	1	703	1670	21	1.14
SG-11-3	Uinta	481	0.07	109	9	0.08	0.13	0.09	<1	199	1350	683	0.40
SG-18A-3	Uinta	370	0.07	70	26	0.09	0.25	0.93	<1	180	920	420	1.61
CB-1R	Uinta	547	0.06	131	23	0.37	1.05	0.63	1	155	1570	770	1.17
44X-1	Uinta	556	0.07	121	11	0.11	0.28	0.11	2	126	1200	486	.069
21Y-12	Uinta	462	0.07	76	87	0.76	0.32	1.14	3	165	862	308	19.6
SG-21-4	Uinta	462	0.13	46	6	0.04	1.60	0.09	<1	188	884	315	0.85
41X-12	Uinta	517	0.08	195	16	<.02	0.17	0.03	<1	176	2030	1150	0.85

9.3.4.1 Benthos

The same methodology, as used in previous years, was employed during the 1985 study. Three sampling stations were sampled 5 times. (Note: The middle sampling station was permanently relocated downstream of its previous location to avoid effects of a newly modified irrigation facility.)

There were only 16 taxa of benthic macroinvertebrates collected from the three sampling stations during the 1985 season, which is relatively few compared to 1984 when 43 taxa were collected. Macroinvertebrate densities were not nearly as high as in 1981 or 1982 (Figure 9-7). However, when the data are examined there are some indications of at least a partial recovery from perturbations experienced in 1983 and 1984 when abnormal flow conditions probably precluded the development of a richer benthic community.

Mean monthly densities ranged from $14/m^2$ in June to $201/m^2$ in September at Stewart Station, the reference site above C-b tract operations. These values are generally lower than at either Middle Station or Hunter Station. At Middle Station densities were lowest in June ($22/m^2$), and increased seasonally to a high of $344/m^2$ in October. June densities were comparatively high at Hunter Station ($301/m^2$); lower in July and August, and reached a seasonal high of $538/m^2$ in September.

Results of the statistical analyses (LSD comparisons, Fisher, 1949) of differences in mean monthly densities between sampling stations indicate that only in October were there statistically significant differences between sampling stations in 1985. These difference are attributed to lower densities at Stewart Station than at either Middle (10% level of significance) or Hunter Station (5% level of significance). Differences between Middle Station and Hunter Station were not statistically significant during 1985.

Diptera, Ephemeroptera and Haplotaxida were the predominate members of the benthic fauna at all three sampling stations in 1985. These groups have been consistently important components of the benthic in previous years at all three sampling stations as indicated in Figure 9-8. Although the number of taxa

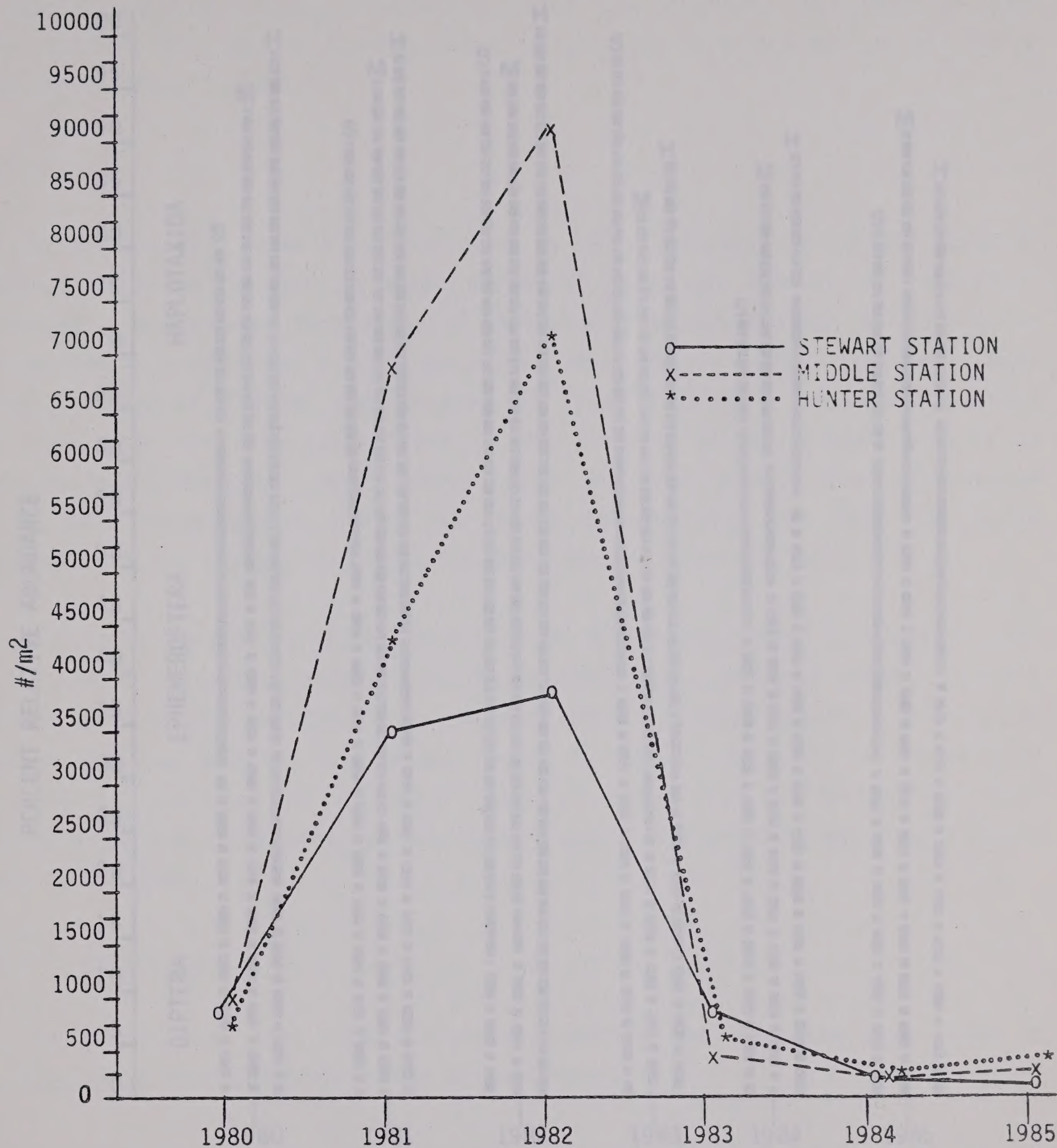

FIGURE 9-7

MEAN OF MONTHLY DENSITIES (#/m^2) OF BENTHIC MACROINVERTEBRATES
AT STEWART, MIDDLE, AND HUNTER STATIONS
DURING MAY THROUGH OCTOBER, 1980-1985

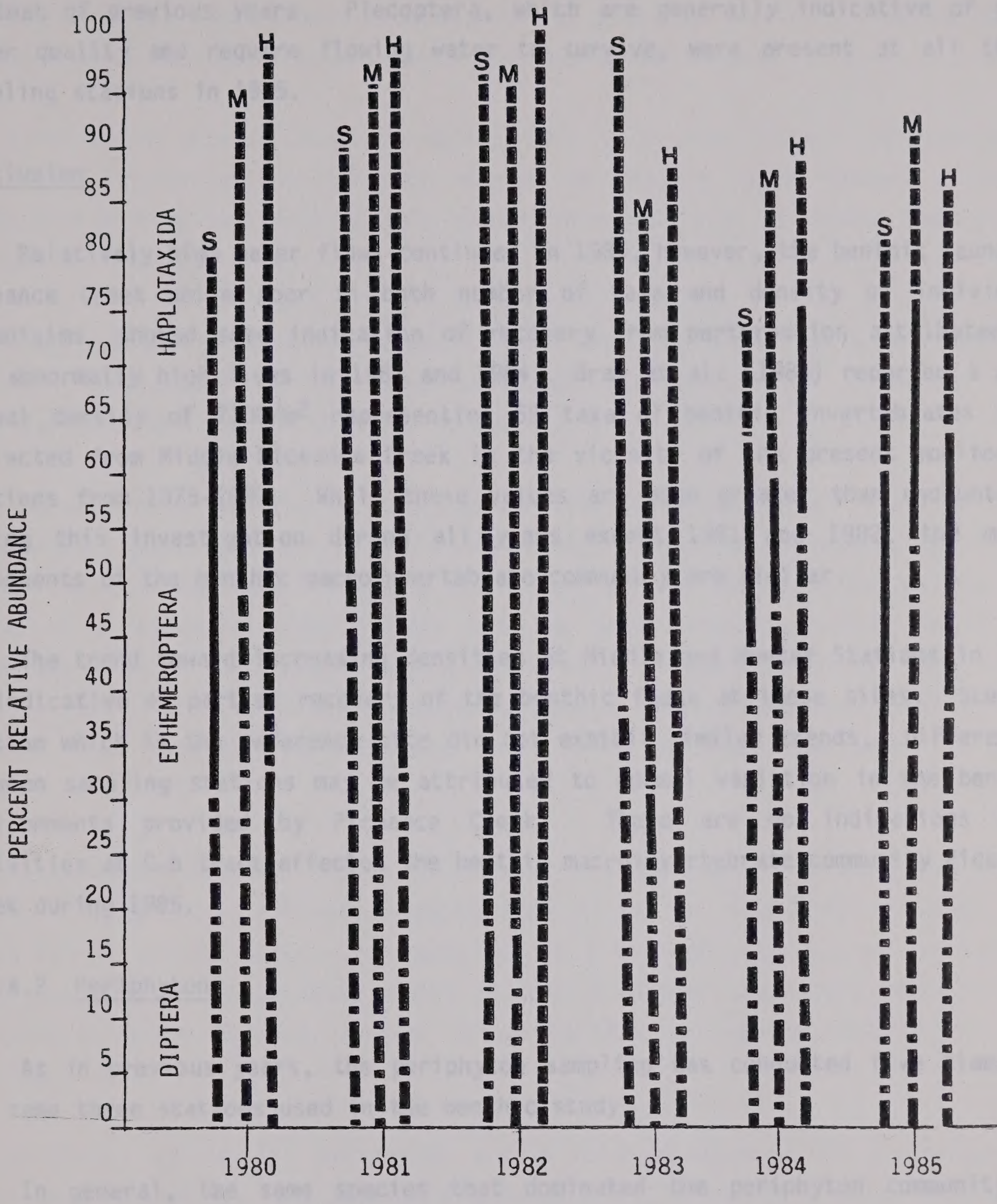

FIGURE 9-8

PERCENT RELATIVE ABUNDANCE OF DIPTERA, EPHEMEROPTERA, AND HAPLOTAXIDA AT STEWART (S), MIDDLE(M), AND HUNTER(H) STATIONS DURING 1980-1985

collected in 1985 was low, the overall quality of the benthic fauna was similar to that of previous years. Plecoptera, which are generally indicative of good water quality and require flowing water to survive, were present at all three sampling stations in 1985.

Conclusion

Relatively high water flows continued in 1985, however, the benthic fauna of Piceance Creek while poor in both number of taxa and density of individual organisims, showed some indication of recovery from perturbation attributed to the abnormally high flows in 1983 and 1984. Gray et al. (1983) reported a mean annual density of 7100/m^2 representing 59 taxa of benthic invertebrates were collected from Middle Piceance Creek in the vicinity of the present monitoring stations from 1975-1980. While these values are much greater than encountered during this investigation during all years except 1981 and 1982, the major components of the benthic macroinvertebrate community are similar.

The trend toward increasing densities at Middle and Hunter Stations in 1985 is indicative of partial recovery of the benthic fauna at these sites. Stewart Station which is the reference site did not exhibit similar trends. Differences between sampling stations may be attributed to normal variation in the benthic environments provided by Piceance Creek. There are no indications that activities at C-b tract effected the benthic macroinvertebrate community Piceance Creek during 1985.

9.3.4.2 Periphyton

As in previous years, the periphyton sampling was conducted five times at the same three stations used in the benthic study.

In general, the same species that dominated the periphyton community in previous years were the dominant species in 1985 (e.g. Achnanthes minutissima, Navicula viridula and Nitzschia dissipata). These species are indicators of high oxygen concentrations in alkaline streams which are slightly to moderately organically enriched (Cholnoky 1968, Lowe 1974, Patrick and Reimer 1966).

Tests in 1980 demonstrated that the relative abundance of periphyton obtained from the periphytometer used prior to 1980 was similar to the relative abundance with the new periphytometer (1980 C-b Annual Report).

Differences between stations during 1985 using the Fisher LSD procedure showed no significant differences except on October when Stewart Station periphyton desnity was significatnly higher than densities at Middle and Hunter Stations ($p = 0.01$).

Mean periphyton density values ranged from 58 algae units/mm^2 (Middle Station - September) to 563 algae units/mm^2 (Hunter Station - August) and exhibited both spatial and seasonal variation.

The periphyton density in 1985 was considerably lower at all stations than in previous sampling years. The differences in monthly periphyton densities between 1985 and the five preceeding years were significant (p.01 to .05) for 42 out of 69 comparisons (61%). This was the same proportion (61%, 34 of 56 comparisons) that was significantly different in comparisons of 1984 with previous year's data (C-b Annual Report, 1984). Periphyton densities at all stations have exhibited a declining trend over the past six years (Figure 9-9).

As expected, seasonal trends in biomass data are similar to those exhibited by the density data. Biomass ranged from a low of 0.087 mg ash-free dry weight/cm^2 at Middle Station in September to a high of 1.124 mg/cm^2 at Hunter Station in August. The biomass peaked in June at Stewart and Middle Stations and in August at Hunter Station, however it was variable during the remainder of the sampling season.

Diversity values for periphyton are a relative measure of environmental stress on a community; they generally decrease with increased stress. Diversity indices for 1985 ranged from a low of 0.85 at Hunter Station in August to a high of 2.33 at Hunter Station in October. The highest diversity value at Stewart and Middle Stations was in June.

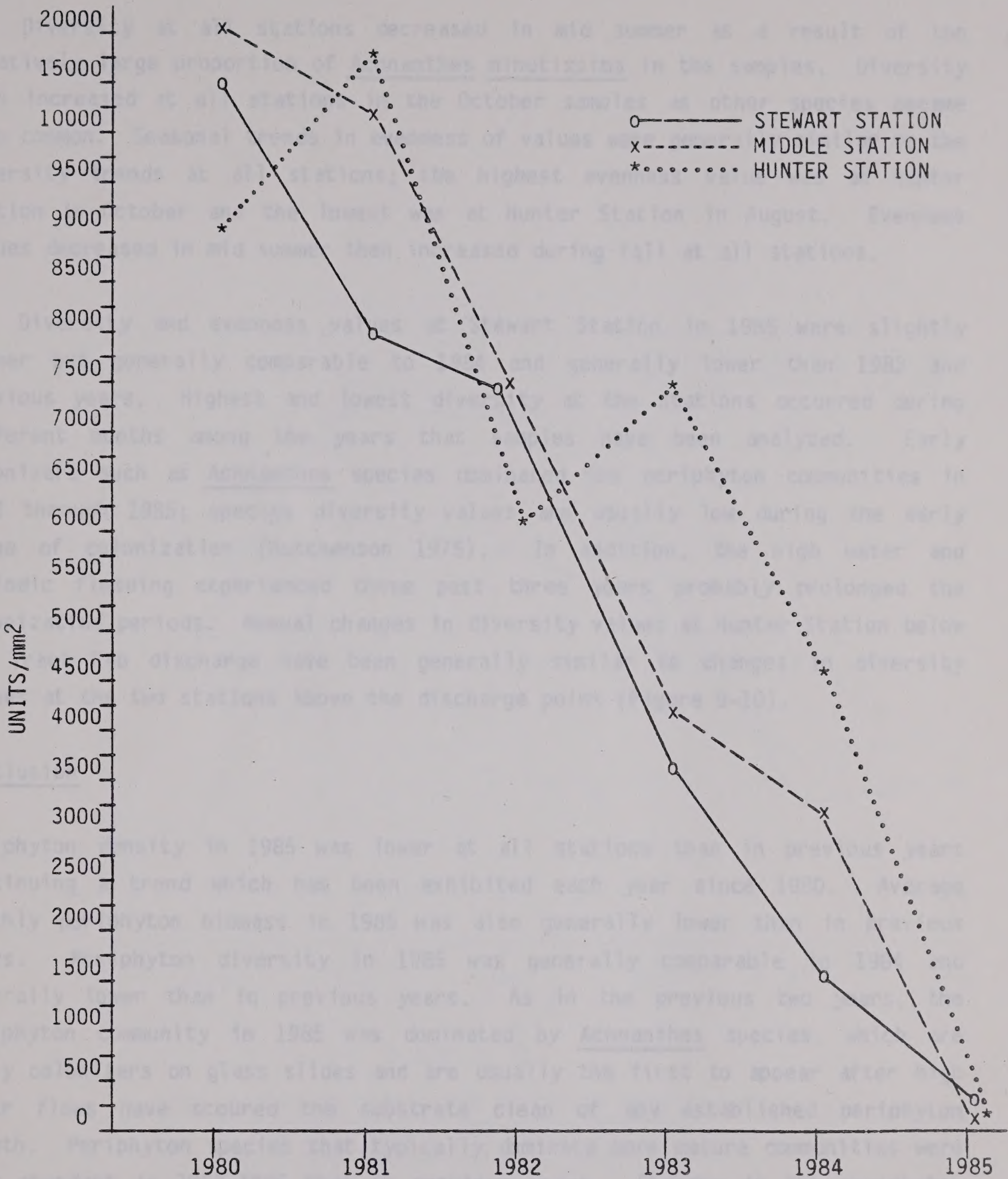

FIGURE 9-9

MEAN OF MONTHLY PERIPHYTON DENSITIES (units/mm^2)
AT STEWART, MIDDLE, AND HUNTER STATIONS
DURING MAY THROUGH OCTOBER, 1980-1985

Diversity at all stations decreased in mid summer as a result of the relatively large proportion of Achnanthes minutissima in the samples. Diversity then increased at all stations in the October samples as other species became more common. Seasonal trends in evenness of values were generally similar to the diversity trends at all stations; the highest evenness value was at Hunter Station in October and the lowest was at Hunter Station in August. Evenness values decreased in mid summer then increased during fall at all stations.

Diversity and evenness values at Stewart Station in 1985 were slightly higher but generally comparable to 1984 and generally lower than 1983 and previous years. Highest and lowest diversity at the stations occurred during different months among the years that samples have been analyzed. Early colonizers such as Achnanthes species dominated the periphyton communities in 1983 through 1985; species diversity values are usually low during the early stage of colonization (Hutchenson 1975). In addition, the high water and periodic flooding experienced these past three years probably prolonged the colonization periods. Annual changes in diversity values at Hunter Station below the Tract C-b discharge have been generally similar to changes in diversity values at the two stations above the discharge point (Figure 9-10).

Conclusion

Periphyton density in 1985 was lower at all stations than in previous years continuing a trend which has been exhibited each year since 1980. Average monthly periphyton biomass in 1985 was also generally lower than in previous years. Periphyton diversity in 1985 was generally comparable to 1984 and generally lower than in previous years. As in the previous two years, the periphyton community in 1985 was dominated by Achnanthes species, which are early colonizers on glass slides and are usually the first to appear after high water flows have scoured the substrate clean of any established periphyton growth. Periphyton species that typically dominate more mature communities were less abundant in 1983-1985 than in previous years. Changes in the periphyton communities have been similar at all three stations during the 1980-1985 period.

Similar changes in the aquatic communities have occurred over the years at Stewart Station, the control, and Hunter Station, downstream of development

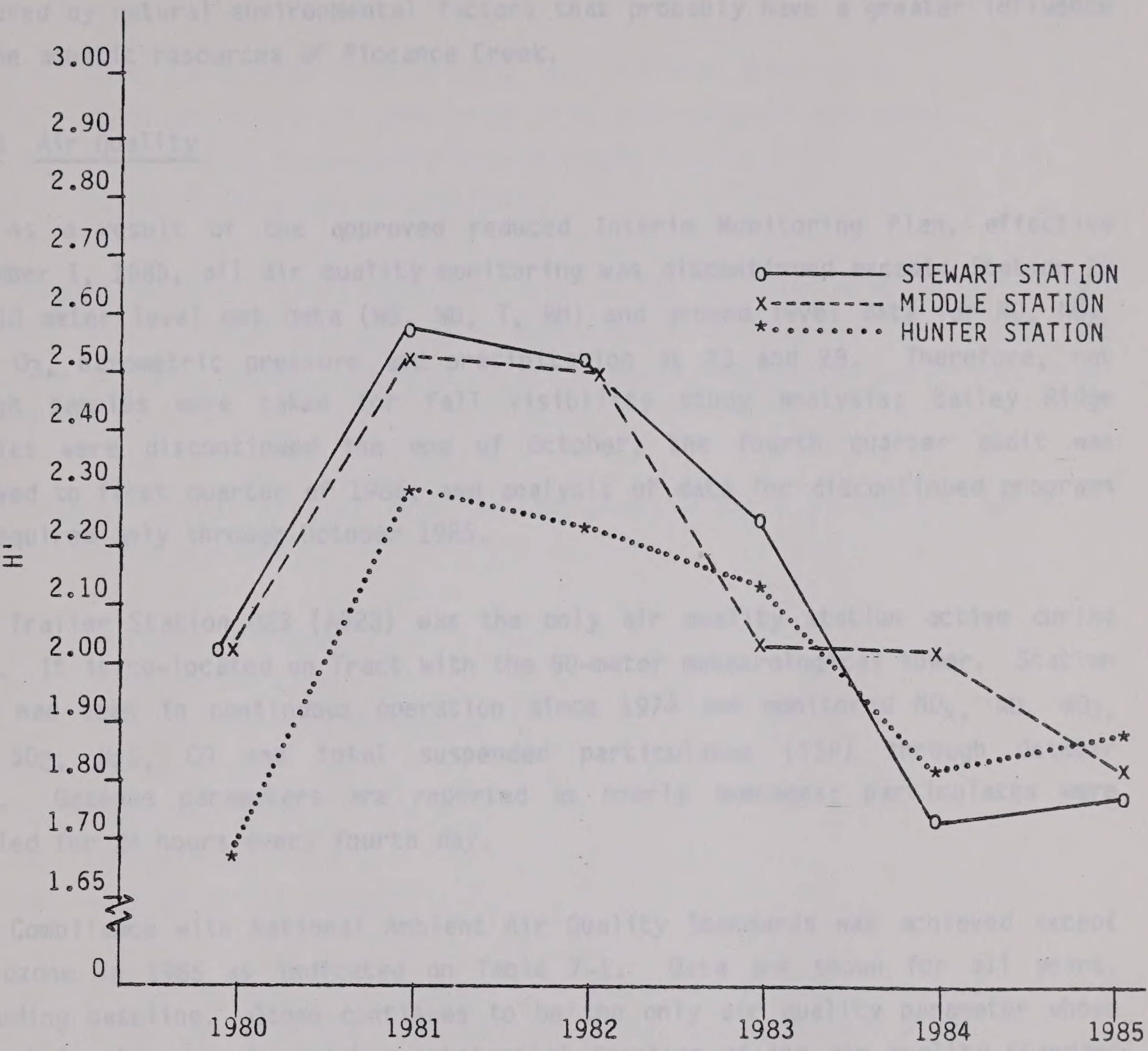

FIGURE 9-10

MEAN OF MONTHLY PERIPHYTON DIVERSITY INDICES (H')
AT STEWART, MIDDLE, AND HUNTER STATIONS
DURING MAY THROUGH OCTOBER, 1980-1985

activity. Variations observed over the years seem to be attributable to natural factors, not to activities at Tract C-b. If the Tract C-b discharge is causing impact to the aquatic ecosystem of Piceance Creek, then this impact apparently is obscured by natural environmental factors that probably have a greater influence on the aquatic resources of Piceance Creek.

9.3.5 Air Quality

As a result of the approved reduced Interim Monitoring Plan, effective November 1, 1985, all air quality monitoring was discontinued except: Station 23 for 10 meter level met data (WS, WD, T, RH) and ground level data for NO, NO_2, NO_x, O_3, barometric pressure and precipitation at 23 and 28. Therefore, not enough samples were taken for fall visibility study analysis; Bailey Ridge Studies were discontinued the end of October; the fourth quarter audit was delayed to first quarter of 1986; and analysis of data for discontinued programs is required only through October 1985.

Trailer Station 023 (AB23) was the only air quality station active during 1985. It is co-located on Tract with the 60-meter meteorological tower. Station AB23 had been in continuous operation since 1974 and monitored NO_x, NO, NO_2, O_3, SO_2, H_2S, CO and total suspended particulates (TSP) through October 1985. Gaseous parameters are reported as hourly averages; particulates were sampled for 24 hours every fourth day.

Compliance with National Ambient Air Quality Standards was achieved except for ozone in 1985 as indicated on Table 7-1. Data are shown for all years, including baseline. Ozone continues to be the only air quality parameter whose ambient levels commonly reach a substantial fraction of the air quality standard or as in 1985, exceed the standard.

High ozone events for April 4, May 10, May 19, May 31 and June 16, 1985 occurred at the C-b Tract. No other high ozone events had occurred since 1979.

These events all appear to be weather related, either associated with local rain and/or thunderstorms or with frontal passages. Dr. George E. Fosdick prepared a report titled "Investigation of High Ozone Events During Spring 1985 at the C-b Tract". The following is a summary of that report:

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As pointed out in earlier work on the C-b Project, (Jones & LaHue (1976) and Jones & Grossman (1976)), possible mechanisms to yield high ozone events are as follows:

(1) local photochemical generation from national precursors,
(2) local photochemical generation from anthropogenic precursors,
(3) influx of an ozone-containing air mass,
(4) injection from the stratosphere.

Jones & Grossman (1976) concludes that of the 12 cases examined (from 1975 and 1976 data) frontal passages were associated with eight of the cases with injection of stratospheric ozone a definite possibility with two of the eight occurrences.

Stephens (1978) relates that the following occur from shortly before to after a frontal passage:

(1) velocity increases
(2) temperature drops
(3) relative humidity increases
(4) NO_2 increases
(5) ozone increases
(6) CO increases
(7) wind direction changes.

Several sources note that transport of ozone for distances in excess of 300 km is possible and that the lifetime for ozone can vary from a few hours in contaminated areas to about 10 days in the lower free troposphere and in excess of 30 days above 5 km.

Johnson & Viezee (1981) report that high concentrations of ozone are due to stratospheric intrusion or tropospheric "folding". (This conclusion is also supported by Wolff, et al (1981)). These concentrations are typically associated with southern portions of low pressure troughs in the upper troposphere. Their

analysis suggest that the four most likely mechanisms whereby stratospheric ozone is injected into the low troposphere are:

"(1) Type 1 - dissipation of the intrusion by general mixing and diffusion into the free troposphere.

(2) Type 2 - persistence of the intrusion down to the atmospheric boundary layer or mixing layer, where the lower portion of the intrusion is mixed down to the ground by turbulent eddies and convection at the top of the boundary layer.

(3) Type 3 - coupling of the intrusion to the frontal zone associated with a cold front, with direct transport of the ozone-rich air to the ground by frontal downdrafts.

(4) Type 4 - similar to Type 3, but with the stratospheric air becoming entrained in organized frontal and prefrontal convection, which then transports it to the ground in connection with rainshowers or thunderstorm downdrafts."

During the spring and early summer of 1985, several high ozone events occurred at the C-b Tract. These events occurred on April 4, May 10, May 19, May 31, and June 16. Data for ozone and NO_x levels, wind speed, barometric pressure, precipitation, and temperature are shown on Table 9-9. Ozone values jumped to as high as 602 ug/m3 during these short-duration events.

For the events of April 4, May 10, and June 16, weather maps were readily available from the Grand Junction office of the National Weather Service. For each event the focus of storm fronts for the day immediately preceeding the event that for the day of the event, and that for the subsequent day have been superimposed on one figure. Thus, the passage of the front over northwestern Colorado can be traced for these 3 events; see Figures 9-11, 9-12, and 9-13. It should be noted that each frontal location corresponds to 7 am Eastern Standard Time. The front with triangles represents a cold front; that with semi-circles is a warm front for which both symbols are used indicates that the front is temporarily stationary. Weather maps show that only the May 10 event had a low pressure trough at the 500 mb height.

Table 9-9

HIGH OZONE EVENTS

03-04 April

Day/Mo / Item	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Hour	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Ozone (ug/m3	74	80	76	78	84	84	84	120	280	443	404	122	208	102	92	102
NO_x (ug/m3)	0	0	0	0	0	0	0	0	0	4	15	9	2	0	0	0
WS (m/s) @ 30m	5	3	3	5	6	5	6	9	12	13	14	10	8	7	4	5
Bar.Pr.- 780 mb	5	4	4	3	2	2	2	2	2	2	2	3	4	5	5	6
Ppt (cm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.16
Temp (°C) @ 10m	5	5	4	4	6	6	6	7	8	7	7	6	4	1	1	2

10 May

Item																		
Hour	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
Ozone	63	76	67	65	63	67	69	71	88	82	137	331	98	106	102	104	102	92
NO_x	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
WS	8	7	5	5	8	7	10	10	11	10	11	15	6	7	8	7	4	4
Bar.Pr.- 780 mb	7	6	6	5	5	4	4	3	2	1	1	2	3	3	3	3	3	4
Ppt (cm)	.03	.03	.13	0	0	0	0	0	0	0	0	.03	0	0	0	0	0	0
Temp(°C) @ 10m	8	8	7	9	12	13	13	15	17	15	15	11	8	9	8	6	4	4

19 May

Item																		
Hour	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
Ozone	71	73	63	65	73	84	104	106	100	100	374	159	118	116	116	104	94	82
NO_x	2	2	2	2	2	2	2	2	2	2	4	4	2	2	2	2	2	2
WS	2	2	1	0	1	2	2	2	2	2	8	8	3	1	3	4	4	2
Bar.Pr. - 780 mb	9	8	9	9	9	9	9	9	8	8	8	8	8	8	8	8	8	8
Ppt (cm)	0	0	0	0	0	0	0	0	.03	0	.06	0	0	0	0	0	0	0
Temp(°C) @ 10m	7	6	6	7	9	11	13	14	13	14	14	12	13	13	14	13	10	8

31 May

Item																				
Hour	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Ozone	92	86	71	71	73	69	74	76	74	78	78	272	82	80	80	65	57	55	55	55
NO_x	2	2	2	4	2	4	2	2	2	4	2	4	2	2	2	2	2	2	2	2
WS	2.5	0.9	2.1	4.1	7.2	7.7	6.5	4.6	5.7	7.3	7.4	5.6	4.1	5.8	1.5	2	4.1	3	1	0.8
Bar.Pr.	10	10	10	10	10	10	11	11	11	10	10	10	10	10	10	10	10	10	10	10
Ppt.						.10							.60							
Temp.	6	8	10	13	13	9	9	9	9	12	13	8	10	12	11	9	8	8	7	8

Table 9-9 (Cont'd)

HIGH OZONE EVENTS

Day/Mo	Item																				
16 June	Hour	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Ozone	67	61	59	63	74	92	92	92	104	120	86	198	602	104	92	88	88	94	94	90
	NO_x	2	2	2	2	4	2	2	2	2	2	4	6	6	8	8	6	4	4	4	4
	WS	1	0	1	1	1	3	7	5	7	6	3	9	16	4	1	1	5	6	8	2
	Bar.Pr.	13	14	14	14	14	14	14	14	13	13	13	13	14	13	14	14	15	14	14	14
	Ppt.											0.32									
	Temp.	16	14	17	19	23	26	26	27	28	26	23	24	22	22	22	21	21	19	18	18

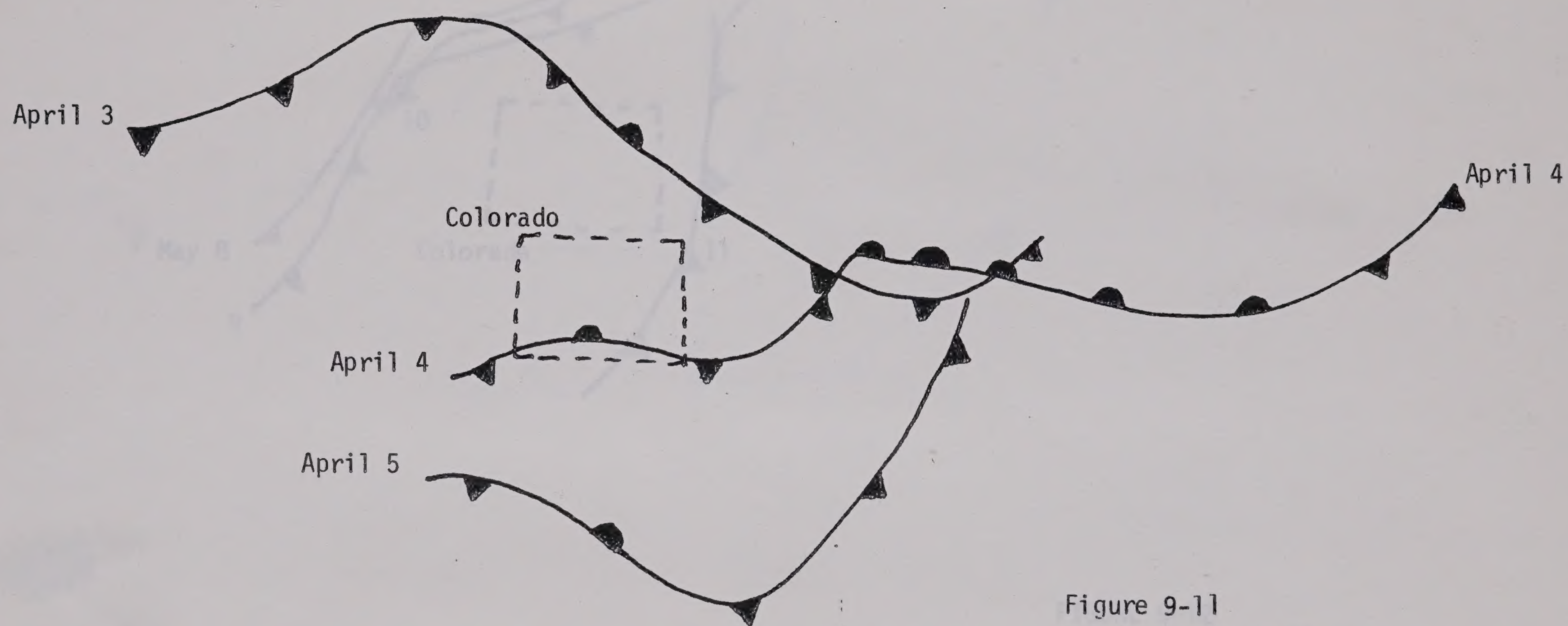

Figure 9-11
Frontal Passages Over
Northwestern Colorado
7 am EST April 4, 1985

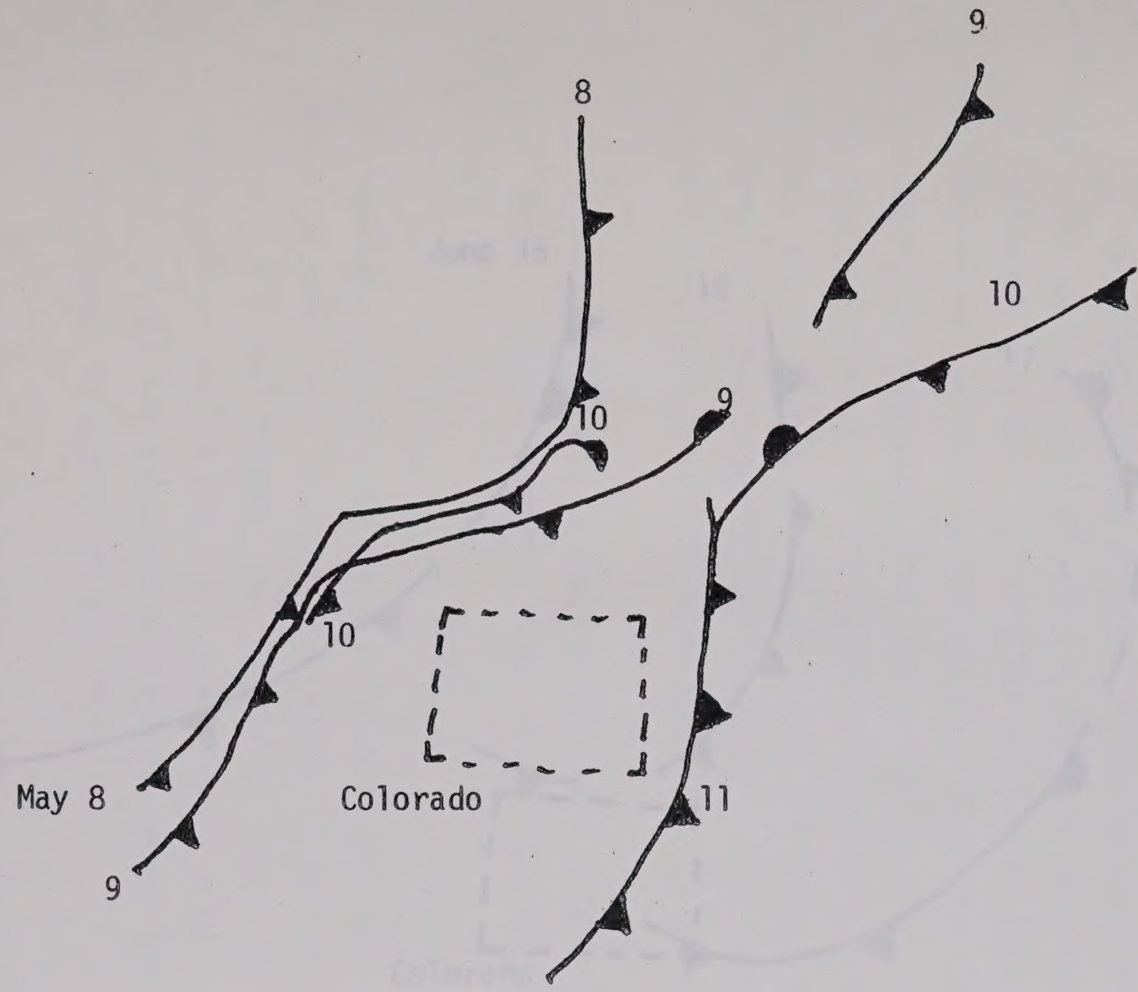

FIGURE 9-12
Frontal Passage Over
Northwestern Colorado
May 10, 1986

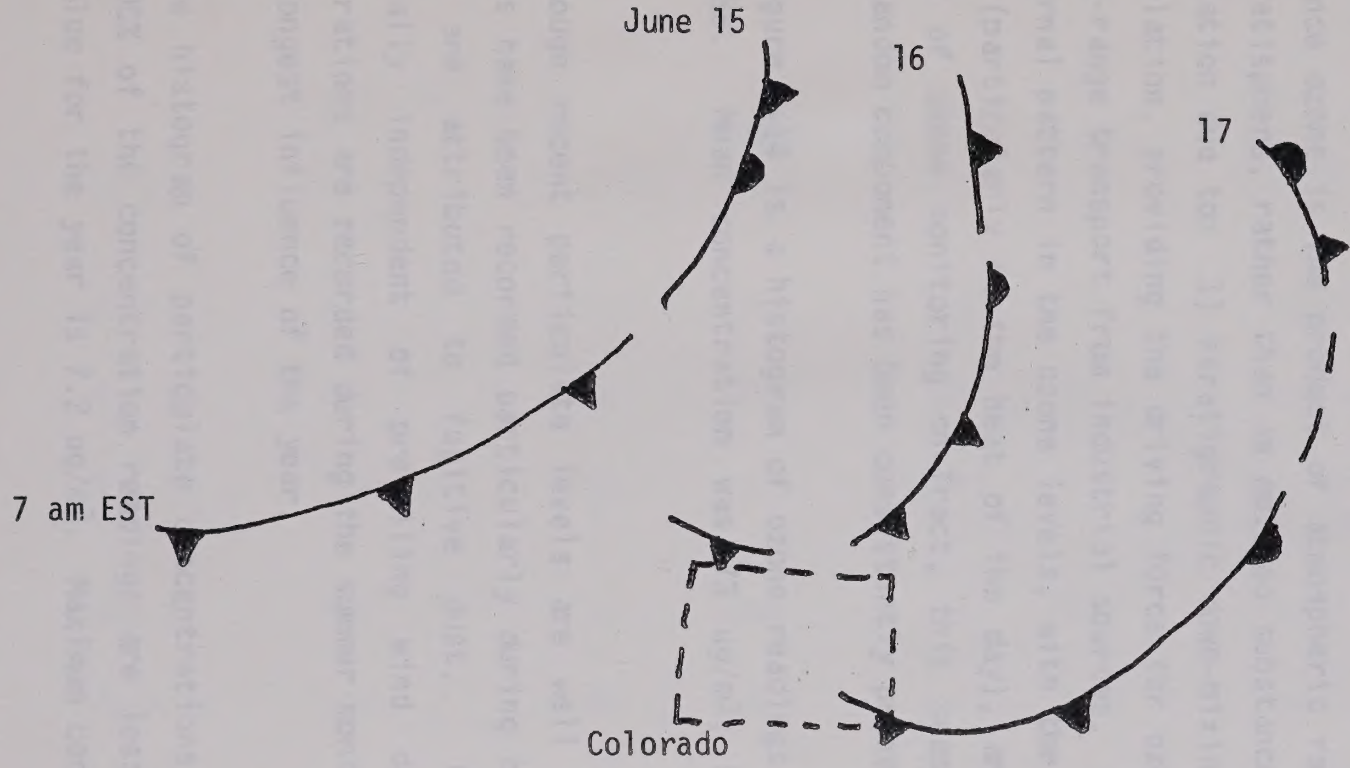

Figure 9-13
Frontal Passage over
Northwestern Colorado
June 16, 1986

Table 9-10 summarizes the characteristics for the events of April 4, May 10, May 19, May 31, and June 16. All events had short-duration, very high ozone values for an undisturbed rural situation. All events showed a temperature drop. Precipitation occurred either just before or during all events except April 4. There was a substantial NO_x increase for only the April 4 and June 16 events. All events exhibited at least a slight wind direction change and all, except May 31, showed a speed increase (followed by a drop-off). Only the events of April 4 and May 10 showed a barometric pressure drop.

Restated, all of the above events appear to be weather related-- either due to local rain and/or thunderstorms or to frontal passages (type 3 or 4 mechanisms as discussed earlier).

Since ozone is the product of atmospheric reactions and is also present in the stratisphere, rather than an emitted substance, its concentration is subject to variation due to: 1) stratigraphic down-mixing, 2) changes in the intensity of insolation, providing the driving force for ozone-producing reactions, and 3) to long-range transport from industrial sources. This results in both a seasonal and diurnal pattern in the ozone levels, with the highest mean concentrations in summer (particularly in the heat of the day), and lowest in winter. Over the history of ozone monitoring on-Tract, this seasonal pattern coupled with the large random component has been consistently present.

Figure 9-14 is a histogram of ozone readings grouped by concentration class for 1985. Mean concentration was 73 ug/m3; highest concentration was 602 ug/m3.

Though recent particulate levels are well below ambient standards, high readings have been recorded particularly during baseline (see Table 7-1). High levels are attributed to fugitive dust. Particulate distributions are essentially independent of prevailing wind directions. High particulate concentrations are recorded during the summer months, when the wind is exhibiting its strongest influence of the year.

The histogram of particulate concentrations for 1985 (Figure 9-15) shows that 10C% of the concentration readings are less than 35 ug/m3; the geometric mean value for the year is 7.2 ug/m3. Maximum concentration was 31.7 ug/m3.

Table 9-10

CHARACTERIZATION OF THE HIGH OZONE EVENTS

Event	Magnitude of O_3 Event ug/m^3	Vel. Increase	Temp. Drop	NO_x Inc.	Ppt. ?	Wind Dir. Change	Bar. Pr. Drop	Passage of Front?	Low Pr. Trough
April 4	443	Yes	Yes	Yes	No	Yes	Yes	Yes	No
May 10	331	Yes	Yes	No	Yes	Small	Yes	Yes	Yes
May 19	374	Yes	Yes	Small	Yes	Big, 2 hrs.later	No	(1)	(1)
May 31	272	No	Yes	No	Yes	Small	No	(1)	(1)
June 16	602	Yes	Yes	Yes	Yes	Yes	No	Yes	No

(1) Weather Maps Not Available

HOURLY OZONE CONCENTRATIONS

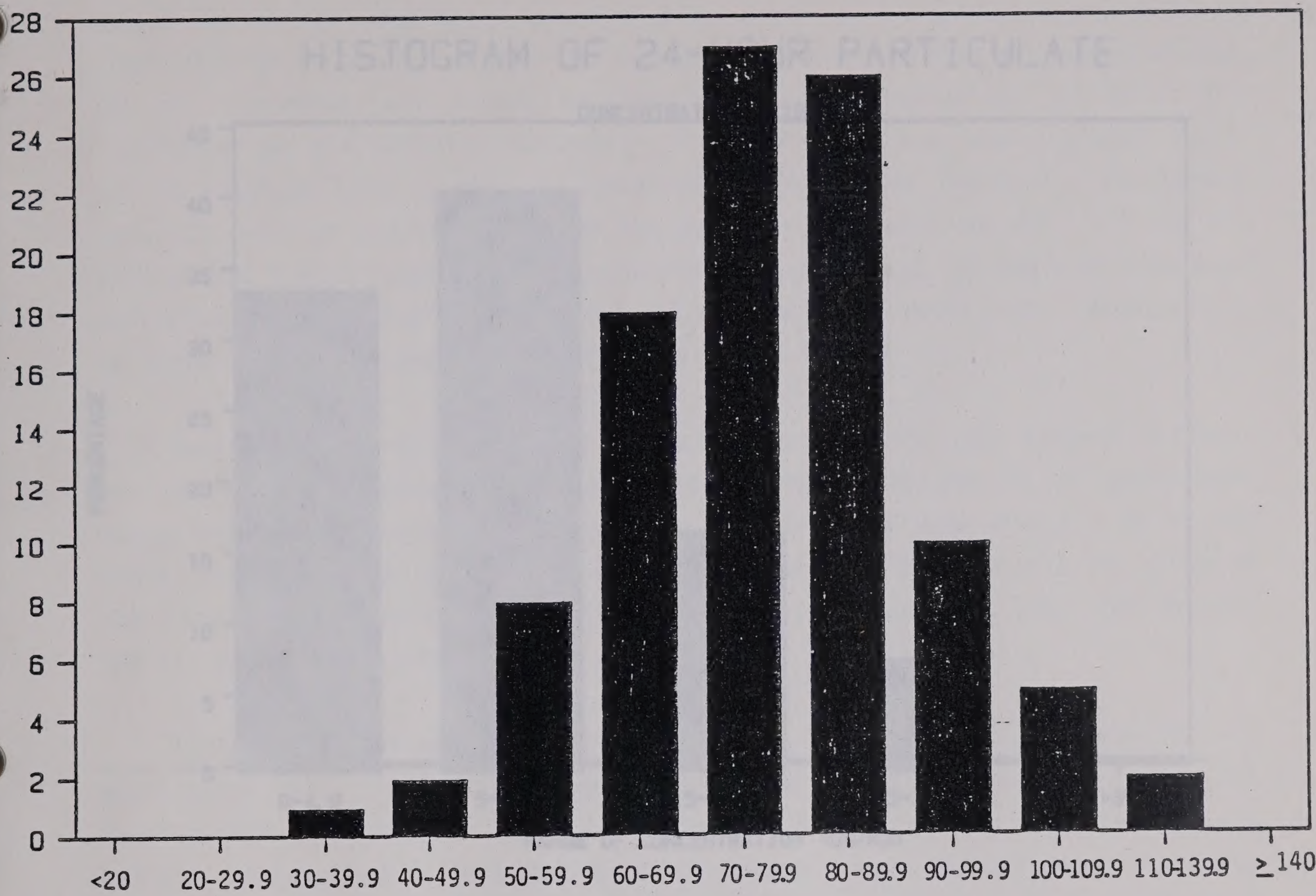

FIGURE 9-14

Yearly Mean = 105.5 ug/m^3

Five highest concentrations for 1985:

602 ug/m^3 6/16/85 @ 1700 hours
443 ug/m^3 4/04/85 @ 1000 hours
404 ug/m^3 4/04/85 @ 1100 hours
374 ug/m^3 5/19/85 @ 1400 hours
331 ug/m^3 5/10/85 @ 1500 hours

HISTOGRAM OF 24-HOUR PARTICULATE

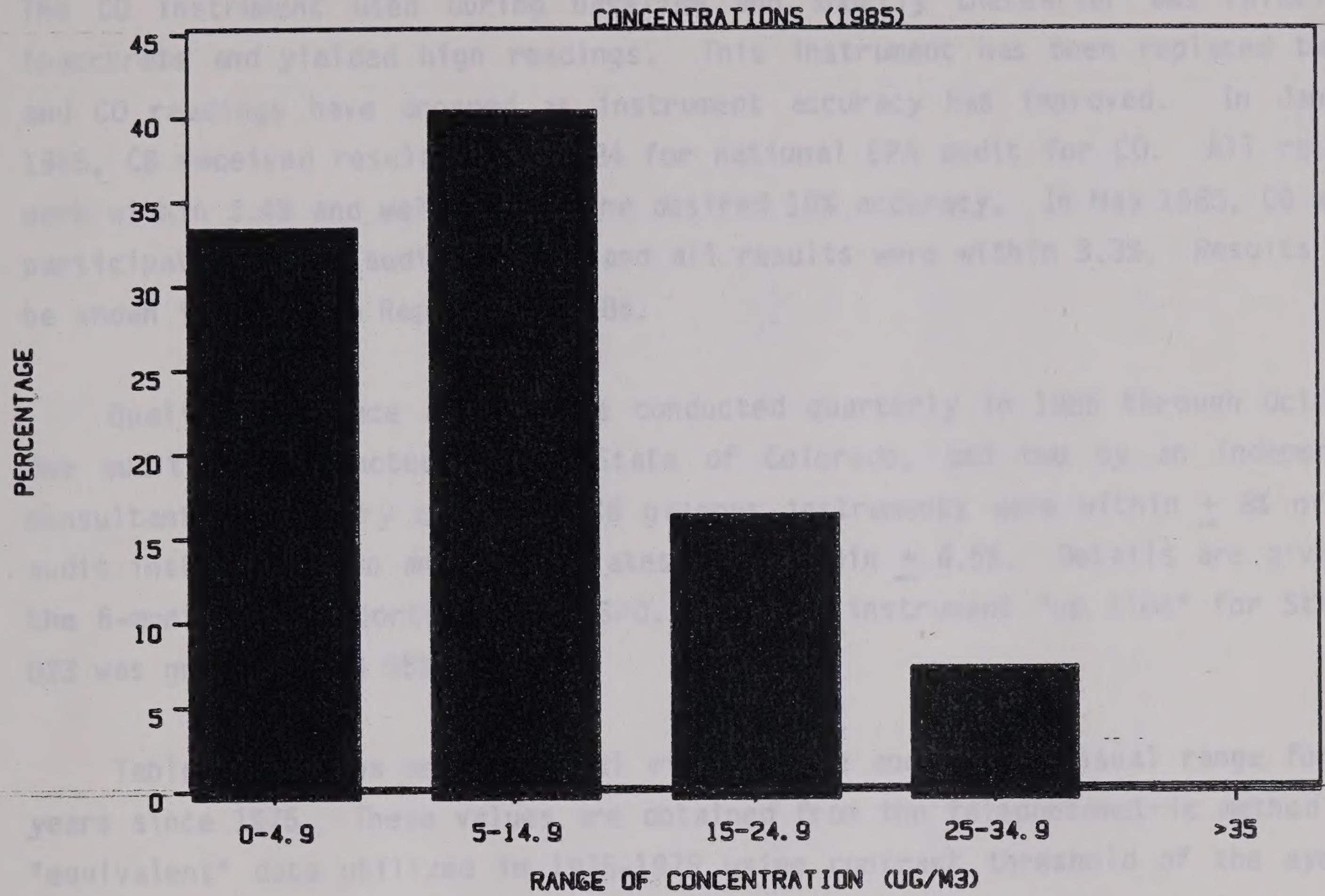

FIGURE 9-15

Five Highest Concentrations for 1985:

31.7 ug/m^3	@ 6/14/85
29.1 "	@ 5/29/85
27.8 "	@ 6/18/85
26.6 "	@ 9/10/85
25.9 "	@ 7/08/85

No significant short or long term trends exist in the air quality data except for carbon dioxide. Carbon dioxide exhibits a negative trend which is attributed to instrument changes throughout the history of the monitoring period. The CO instrument used during baseline and shortly thereafter was relatively inaccurate and yielded high readings. This instrument has been replaced twice, and CO readings have dropped as instrument accuracy has improved. In January 1985, CB received results from 1984 for national EPA audit for CO. All results were within 3.4% and well within the desired 10% accuracy. In May 1985, CB again participated in EPA audit for CO, and all results were within 3.3%. Results will be shown in the Data Report for 1986.

Quality assurance audits were conducted quarterly in 1985 through October. One audit was conducted by the State of Colorado, and two by an independent consultant. In every case, all CB gaseous instruments were within ± 8% of the audit instrumentation and particulates were within ± 6.5%. Details are given in the 6-month data reports to the OSPO. Overall instrument "up time" for Station 023 was greater than 95%.

Table 9-11 shows mean seasonal visual range and annual visual range for all years since 1975. These values are obtained from the telephotometric method with "equivalent" data utilized in 1975-1978 using contrast threshold of the eye, $C_m = 0.05$, as described in last year's Annual Report. Mean annual visual range for 1985 was 88 miles; for 1984 it was 76 miles; the annual average since 1975 has been 84 miles.

It is of interest to note the comparison between the observer's estimated visual range and that obtained from the telephotometer. Observer estimates are shorter than measured values primarily due to the fact that the farthest away target is only 54 miles in this view, i.e., closer than the measured visual range.

9.3.6 <u>Meteorology and Climate</u>

Climatological parameters measured include wind speed and direction, temperature (and delta temperature from 60 to 10m), solar radiation, precipitation, relative humidity, and barometric pressures. These records serve

TABLE 9-11

Mean Seasonal and Annual Visual Range
1975 - 1985
(Miles)(1)

		VIEW				
		1	2	3	4	All Views
Year	Season	Visual Range	Visual Range	Visual Range	Visual Range	Visual Range
1975*	Spring	-	-	-	-	-
	Fall	94	79	84	95	88
	Yearly	94	79	84	95	88
1976*	Spring	78	70	-	81	76
	Fall	-	-	82	-	82
	Yearly	82	72	73	84	78
1978*	Spring	84	76	72	86	80
	Fall	97	77	69	87	82
	Yearly	89	76	71	86	81
1979	Spring	80	71	79	115	86
	Fall	99	78	95	131	101
	Yearly	90	75	87	123	94
1980	Spring	81	68	78	107	83
	Fall	94	76	81	113	91
	Yearly	87	72	80	110	87
1981	Spring	71	66	67	94	74
	Fall	82	72	83	102	85
	Yearly	77	69	75	99	80
1982	Spring	80	75	81	110	86
	Fall	92	80	90	119	95
	Yearly	87	78	86	115	91
1983	Spring	82	70	61	74	72
	Fall	95	79	70	91	84
	Yearly	88	75	65	82	78
1984	Spring	81	75	70	106	83
	Fall	76	69	58	74	69
	Yearly	79	72	64	90	76
1985	Spring (only)	85	79	84	105	88
All Years	Spring	80	72	74	98	81
	Fall	91	76	79	102	87
	Yearly	86	74	76	100	84

* Data are estimated "equivalent" telephotometric values.
(1) All historical data have been corrected using $C_m = 0.05$ as explained in the text.

as a historical data base to assess climatological effects on the biotic portion of the ecosystem so they may subsequently be sorted from potential man-induced effects. Hourly values are reported in the 6-month data reports.

The wind data are also used to obtain Pasquill-Gifford atmospheric stability and wind persistence information for use in air diffusion modeling studies. Figure 9-16 is the annual wind rose for 1985. Prevailing winds on-tract continued to be from the SSW. Those in Piceance Creek are constrained to follow the valley walls. C-b's stability classes generally range from stable (i.e., Classes E and F) to neutral (Class D).

Precipitation for Water Year 1985 (October 1984 - September 1985) was approximately 18.57 inches vs. 18.9 inches in 1984, two wet years in comparison to other recorded years. See Table 9-12 for calendar year comparisons of monthly precipitation for 1980 (a dry year at 13-14 inches) and 1984 at both Little Hills and C-b Station 023 (a wet year at 19-20.6 inches). A regression equation was used to estimate missing values for Station 023 in the table, as indicated in previous reports.

9.3.7 Noise

The environmental noise program was discontinued during the Interim Monitoring Period.

9.3.8 Wildlife Biology

The wildlife monitoring program for 1985 consisted of studies of mule deer, coyotes, lagomorphs, small mammals, browse, avifauna and mitigation projects. (Note: Transect BA 33 (deer pellet and browse transect) was initiated to replace BA 27 which was damaged by woodcutting activities).

A bite count study and a fecal/stomach analysis study were also conducted. These two additional studies were conducted to aid in determining food preferences of mule deer in the C-b Tract area and to aid in improving reclamation planning for wildlife.

FIGURE 9-16

AA23 ANNUAL WIND ROSE AT 10M

JAN '85 - DEC '85

TOTAL % OF CALMS DISTRIBUTED (0.00%)

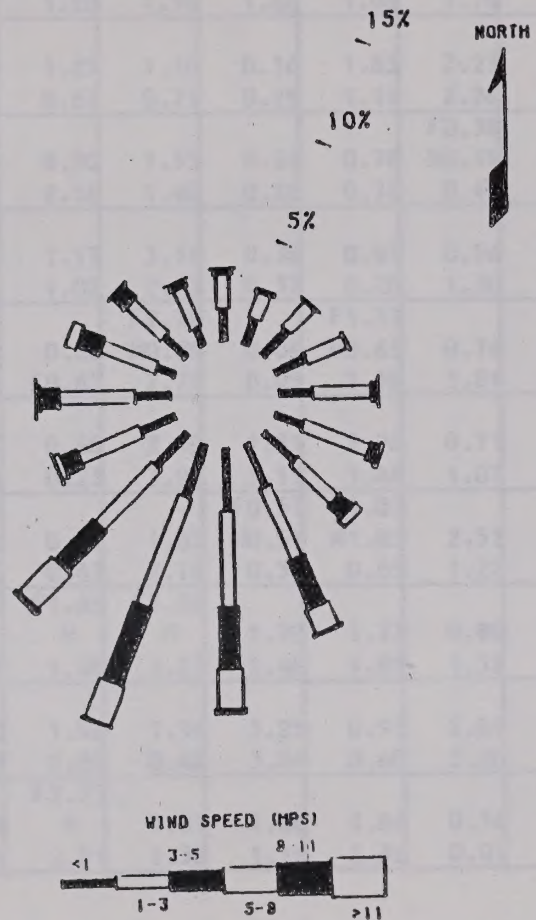

TABLE 9-12

Precipitation (in.) for C-b and Little Hills 1975-1985

Station	Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
C-b Sta. 023 Little Hills	1975	F0.71 0.80	F0.40 0.50	F1.15 1.22	F1.53 1.58	F2.32 2.33	F1.71 1.75	F3.02 3.00	F0.25 0.36	F0.63 0.72	F1.50 1.55	F0.66 0.75	F0.69 0.78	F14.57 15.34
C-b Sta. 023 Little Hills	1976	F0.36 0.47	F0.65 0.74	F1.60 1.65	F1.13 1.20	F1.93 1.96	F1.55 1.60	F1.00 1.08	F1.75 1.79	F1.14 1.21	F0.44 0.54	F0.0 0.10	0.39 0.10	F11.94 12.44
C-b Sta. 023 Little Hills	1977	0.80 0.26	0.53 0.44	1.58 0.95	1.25 0.87	1.10 0.71	0.16 0.29	1.85 1.19	2.23 2.26	1.47 0.91	0.88 1.22	1.44 1.25	0.85 0.70	14.14 11.05
C-b Sta. 023 Little Hills	1978	0.65 1.16	1.04 0.70	3.29 2.01	0.90 2.18	1.55 1.40	0.51 0.28	0.78 0.76	F0.38 M0.19 0.49	0.55 0.98	0.08 0.20	1.77 1.68	0.36 1.48	F11.86 13.32
C-b Sta. 023 Little Hills	1979	1.07 0.93	0.62 0.61	1.51 2.45	1.17 1.02	3.34 2.53	0.38 0.32	0.85 0.28	0.86 1.30	0.28 0.25	1.83 1.56	2.10 1.66	0.45 0.39	14.46 13.30
C-b Sta. 023 Little Hills	1980	1.12 1.15	1.39 1.61	2.26 2.07	0.88 E0.65	F2.78 M0.89 2.77	0.06 0.03	F1.32 M0.65 1.38	0.76 1.81	0.37 0.81	1.17 1.20	0.68 E0.68	0.37 0.33	F13.16 E14.49
C-b Sta. 023 Little Hills	1981	0.66 0.20	0.34 0.76	1.26 2.82	0.60 0.23	2.45 3.20	1.33 1.11	1.26 1.44	0.71 1.07	1.17 0.44	3.05 4.32	0.25 0.54	1.18 1.09	14.26 17.22
C-b Sta. 023 Little Hills	1982	0.88 0.76	F0.69 M0.69 0.48	F0.79 M0.56 0.88	0.81 0.43	1.83 2.16	F0.57 M0.57 0.39	F1.03 M1.03 0.85	2.51 1.22	2.94 3.81	F1.59 M0.71 M1.64	1.28 M1.13	0.98 0.84	F15.90 M14.59
C-b Sta. 023 Little Hills	1983	F0.15 M 0.27	F0.96 M 1.04	F1.60 M 1.65	F1.85 M 1.89	F3.26 M 3.23	1.90 2.48	1.33 1.85	0.80 1.52	0.37 0.73	1.24 2.18	1.23 1.51	1.46 1.83	F16.15 20.18
C-b Sta. 023 Little Hills	1984	0.65 0.46	0.61 0.63	1.90 2.09	1.96 2.84	1.34 0.48	3.25 3.84	0.91 0.60	2.84 3.00	1.50 1.78	3.63 2.31	0.54 0.71	1.45 0.58	20.58 19.32
C-b Sta. 023 Little Hills	1985	1.07 1.06	0.72 0.42	1.74 1.68	F2.93 M 2.91	1.01 1.38	1.06 1.16	2.86 2.32	0.36 0.07	1.24 1.30				

M = Missing Data
E = Estimated, Little Hills (by Little Hills)
F = Estimated for C-b from regression

Regression: $y = a + bx = 0.12 + 0.95x$ or $x = 1.05y - 0.13$
y = Little Hills monthly precipitation (in.)
x = C-b Station 023 monthly precipitation (in.)
79 sample pairs (thru Sept. '84)
r^2 = Coefficient of Determination = 0.65

After analyzing results from all wildlife studies, no effects of any biological importance were attributable to disturbance effects (impacts) on the Tract.

9.3.8.1 Mule Deer

9.3.8.1.1 Pellet-Group Counts

Pellet group counts were conducted along 46 transects: 18 in chained rangeland habitat, 12 in pinyon-juniper habitat, and 15 in the two brush beating areas. These counts were conducted to monitor distribution of wintering deer on and in the near vicinity of Tract C-b.

The pellet-group density estimates are shown on Table 9-13. This data was compared to data from the past 8 years (1977-78 through 1984). The data was reviewed to find the following situations should they occur: 1) a trend toward lower pellet-group densities at transect locations close to development activities, accompanied by higher densities at control locations (indicative of a permanent displacement of deer from areas near development); 2) a temporary shift toward lower pellet-group densities at localized disturbance sites (indicative of short-term displacements); 3) a return to previous pellet-group density levels following a localized impact (indicative of habituation to disturbance); and 4) any consistent pattern in the data that provides insight into the manner in which deer use the area on a year-to-year basis.

No displacements of deer near any transects or any other unusual anomalies were evident after examining this year's data; therefore, no additional statistical testing will be conducted. Data on pellet-group density estimates for this past year were shown in the January 1986 Data Report.

Evaluations of the success of the sagebrush beating (2-level ANOVA) have been evaluated the past 4 years with no evidence obtained for increased numbers of deer (higher pellet-group densities) in brush-beaten areas. As in previous years, the 1985 differences between treatment and control were insignificant ($F=2.07$; $df=1,7$; $P>0.20$).

TABLE 9-13 Deer pellet-group densities, 1984-85.

Transect	Mean pellet-groups per .01 acre plot +/- SE (n)*
Chained rangeland:	
BA17	1.20 +/- 0.29 (20)
BA18	2.79 +/- 0.43 (19)
BA25	3.25 +/- 0.60 (20)
BA20	3.10 +/- 0.54 (20)
BA21	6.25 +/- 0.88 (20)
BA23	3.05 +/- 0.42 (20)
BA01	3.70 +/- 0.49 (20)
BA02	3.15 +/- 0.61 (20)
BA03	2.20 +/- 0.40 (20)
BA04	5.70 +/- 0.97 (20)
BA05	1.40 +/- 0.33 (20)
BA06	0.60 +/- 0.22 (20)
BA07	0.40 +/- 0.17 (20)
BA08	1.35 +/- 0.40 (20)
BA09	0.95 +/- 0.18 (20)
BA30	1.95 +/- 0.48 (20)
BA31	2.65 +/- 0.40 (20)
BA32	3.75 +/- 0.45 (20)
Pinyon-juniper woodland:	
BA19	0.80 +/- 0.17 (20)
BA26	0.95 +/- 0.29 (20)
BA27	2.05 +/- 0.52 (20)
BA16	1.25 +/- 0.27 (20)
BA22	1.75 +/- 0.34 (20)
BA24	1.00 +/- 0.25 (20)
BA10	1.10 +/- 0.22 (20)
BA11	1.95 +/- 0.32 (20)
BA12	2.40 +/- 0.48 (20)
BA13	4.24 +/- 0.85 (20)
BA14	8.75 +/- 0.90 (20)
BA15	4.20 +/- 0.65 (20)
Brush-beaten plots:	
BA33	1.55 +/- 0.34 (20)
BA41	0 0
BA42	0.55 +/- 0.20 (20)
BA43	0.20 +/- 0.09 (20)
BA44	2.60 +/- 0.46 (20)
BA45	0.45 +/- 0.20 (20)
BA46	0.30 +/- 0.16 (20)

Note: Casual observations continue to show heavy cattle use in the sagebrush bottoms and little cattle use on the slopes. This sift in pre-beating utilization pattern by livestock could be beneficial to wildlife since more of the browse and grasses on the slopes is being left for wildlife to use.

Studies of elk have never been part of C-b monitoring because of the lack of elk use in close proximity to the Tract. However, in the past few years, elk observations near the tract and along the Piceance Creek Highway are increasing. Small groups of elk were seen along the road while conducting the deer studies. Elk pellet-groups were also found along 16 of the 46 deer pellet-group transects. A total of 53 groups were found this year as compared to 46 during the 1983-84 study period. The transects numbers (omitting the BA prefix) with numbers of pellet-groups shown in parenthesis are: 04(4); 7(1); 8(3); 9(4); 17(5); 18(8); 19(4); 21(1); 25(1); 27(3); 48(2); 51(2); 52(5); 53(3); 55(3); 56(4).

9.3.8.1.2 Browse Production and Utilization

Studies on bitterbrush production and utilization were conducted along 20 transects in two habitat types: chained rangeland (13 transects) and pinyon-juniper (7 transects). The study is designed to estimate current annual growth available to deer and percent utilization of the yield.

Data for the 1984-85 season are presented in Table 9.14. The data was analyzed using a format similar to that for summarizing deer pellet-group densities. No unusual anomalies were evident. Utilization this past year averaged 70%, which tends to be intermediate in terms of the variation encountered over the past 8 years. The suggested acceptable utilization rate of bitterbrush is 50% (Shepard, 1971) with 80% use resulting in damage and killing of the shrubs. Very few shrubs were damaged by rodents this year.

9.3.8.1.3 Sagebrush Utilization

Sagebrush utilization data was collected using ocular estimates along 26 transects. Both bitterbrush and sagebrush studies are valuable in characterizing browse utilization. They are used as a second approach for detecting development-induced changes in the distribution of mule deer on and near C-b Tract.

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9.3.8.1.2 <u>Browse Production and Utilization</u>

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Sagebrush utilization data was collected using ocular estimates along 26 transects. Both bitterbrush and sagebrush studies are valuable in characterizing browse utilization. They are used as a second approach for detecting development-induced changes in the distribution of mule deer on and near C-b Tract.

TABLE 9-14 Browse production and utilization, 1984-85.

Transect	A PRODUCTION length of new shoots in fall (mm) Mean +/- SE (n)*	B Length of shoots remaining in spring (mm) Mean +/- SE (n)	C UTILIZATION in percent (A-B)/A
CHAINED RANGELAND:			
BA17	179 +/- 17.0 (10)	79 +/- 8.4 (10)	56
BA18	229 +/- 31.4 (10)	92 +/- 17.1 (10)	60
BA25	209 +/- 22.7 (10)	59 +/- 11.0 (10)	72
BA01	286 +/- 28.3 (10)	53 +/- 5.2 (10)	81
BA04	199 +/- 27.1 (10)	56 +/- 9.8 (10)	72
BA06	275 +/- 24.5 (10)	93 +/- 11.5 (10)	66
BA09	190 +/- 21.7 (10)	84 +/- 14.2 (10)	56
BA30	240 +/- 21.0 (10)	60 +/- 8.6 (10)	75
BA31	244 +/- 21.6 (10)	47 +/- 6.5 (10)	81
BA32	196 +/- 10.4 (10)	34 +/- 4.7 (10)	83
BA20	215 +/- 35.9 (10)	61 +/- 16.8 (10)	72
BA21	206 +/- 23.9 (10)	86 +/- 17.2 (10)	58
BA23	239 +/- 20.4 (10)	65 +/- 9.3 (10)	73
			AVERAGE = 70
PINYON-JUNIPER WOODLAND:			
BA19	168 +/- 20.5 (10)	78 +/- 16.6 (10)	54
BA26	186 +/- 22.0 (10)	35 +/- 4.4 (10)	81
BA27	184 +/- 26.8 (10)	61 +/- 12.4 (10)	67
BA16	159 +/- 17.6 (10)	34 +/- 5.1 (10)	79
BA22	220 +/- 26.9 (10)	64 +/- 7.4 (10)	71
BA24	218 +/- 68.0 (10)	68 +/- 9.5 (10)	69
BA33	208 +/- 17.3 (10)	75 +/- 13.9 (10)	64
			AVERAGE = 69

* n = number of shrubs sampled.

Sagebrush ocular estimates for 1978-85 are listed in Table 9-15. Sagebrush utilization rates are still decreasing in both the chained and pinyon-juniper habitats. As in the past, comparisons with previous years' data does not indicate that activities on C-b Tract are effecting sagebrush growth or utilization rates.

9.3.8.1.4 Migrational Phenology, and Off-Site Deer Abundance

Migrational phenology data are collected by obtaining deer counts along the entire Piceance Creek Highway (42 miles). The phenology study is designed to monitor deer distributions along the highway in order to detect displacements of deer near C-b Tract.

Patterns from this year's data are similar to patterns seen in previous years' data. For instance, meadows and other habitats adjacent to the road that are used by deer for one year tend to be the same in other years. This means that major displacements of deer near Tract C-b would be readily detectable as a conspicuous decline in deer numbers along mile 16 through 20.

The total number of deer seen along the highway this year was 7659 deer, as compared to the highest total of 13,943 established in 1983-84 sampling period. Only two seasons (in the 8 year study period) have had lower yearly totals. The low total count is a combination of a lower deer population and winter conditions.

9.3.8.1.5 Age Class

The age class study was conducted within a 5 mile area of Tract C-b. The data collected are used to predict fawn-adult ratio in the fall and spring.

The fawn/adult ratio in December 1984 was 54 fawns/100 adults whereas in April 1985 it was down to 12 fawns/100 adults. Over 50% of the fawn died during the winter which has been the norm for several years. This data is more qualitative than quantitative and is used in conjunction with other studies to observe possible trends in the mule deer populations.

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TABLE 9-15 SAGEBRUSH OCULAR ESTIMATE
1978 - 1985

CHAINED PINYON JUNIPER HABITAT

Year	Growth Form Young	Mature	Decadent	Utilization Low	Medium	High	Shrub Density
1985	21.1	78.6	0.3	96.8	3.2	0.0	266
1984	20.3	76.0	3.7	92.6	7.1	0.3	313
1983	16.8	82.3	0.9	90.3	9.7	0.0	341
1982	20.3	78.5	1.2	82.0	17.5	0.5	338
1981	28.8	68.6	2.6	64.9	32.0	3.1	259
1980	19.5	73.3	6.2	54.0	40.0	6.0	339
1978	7.2	88.0	4.8	41.9	39.3	18.8	309

PINYON JUNIPER HABITAT

Year	Growth Form Young	Mature	Decadent	Utilization Low	Medium	High	Shrub[1] Density
1985	4.5	82.5	13.0	88.7	10.0	1.3	76
1984	1.4	73.2	25.4	69.1	28.0	2.9	75
1983	1.1	78.9	20.0	56.6	35.1	8.3	76
1982	1.1	70.3	28.6	49.4	42.0	8.6	79
1981	1.4	76.2	22.2	45.9	40.0	14.1	97
1980	2.3	52.4	45.3	17.7	38.7	43.6	98
1978	0	48.6	51.4	5.8	40.4	53.8	88

[1] $\text{Sagebrush plants/acre} = \dfrac{\text{Number of shrubs counted}}{\text{Number of sample points}} \times \text{Basal Area Factor}$

Basal Area Factor = 40

9.3.8.1.6 Roadkills

Roadkill data was collected along the Piceance Creek Highway to quantify the frequency of kills and to evaluate the casual factors involved.

Only 51 deer were killed by vehicles during the 1984-85 study period. This is the second lowest total roadkill since the study began in 1977. This year's class breakdown showed a large shift in kills from mature does to female fawns. The 8 year means for class breakdowns (Table 9-16) are 50% for does and 25% for female fawns compared to this year's figures of 33% for does and 53% for female fawns. There is no explanation for this shift to female fawns; the age sex ratio of the herd is still similar to previous years. This shift might just be an anomally for this year. It will be interesting to observe the results of next year's study.

The cumulative Piceance Creek roadkill is shown in Figure 9-17.

9.3.8.1.7 Natural Mortality

Natural mortality data was collected in 4 sagebrush draws north of C-b Tract. The main objective of the study was to document yearly trends which aid interpretation of other monitoring studies.

Only 6 deer carcasses were found in the 1985 mortality study. This represents an estimate of .2 carcasses per hectare vs. the 10 year average of .53 carcasses per hectare. Due to the large fluctuation in the deer herd size and weather, care should be taken in extrapolating trends only from this study.

9.3.8.2 Lagomorph Abundance

Cottontail and jackrabbit abundance studies were conducted on the deer pellet-group transects. The studies were directed toward documenting trends in levels of abundance and aiding in impact detection. Pellet frequency data for both cottontails and jackrabbits were given in the January 1986 Data Report.

TABLE 9-16

Piceance Creek Road Kill
(Piceance Creek Road from 0 thru Mile 41)

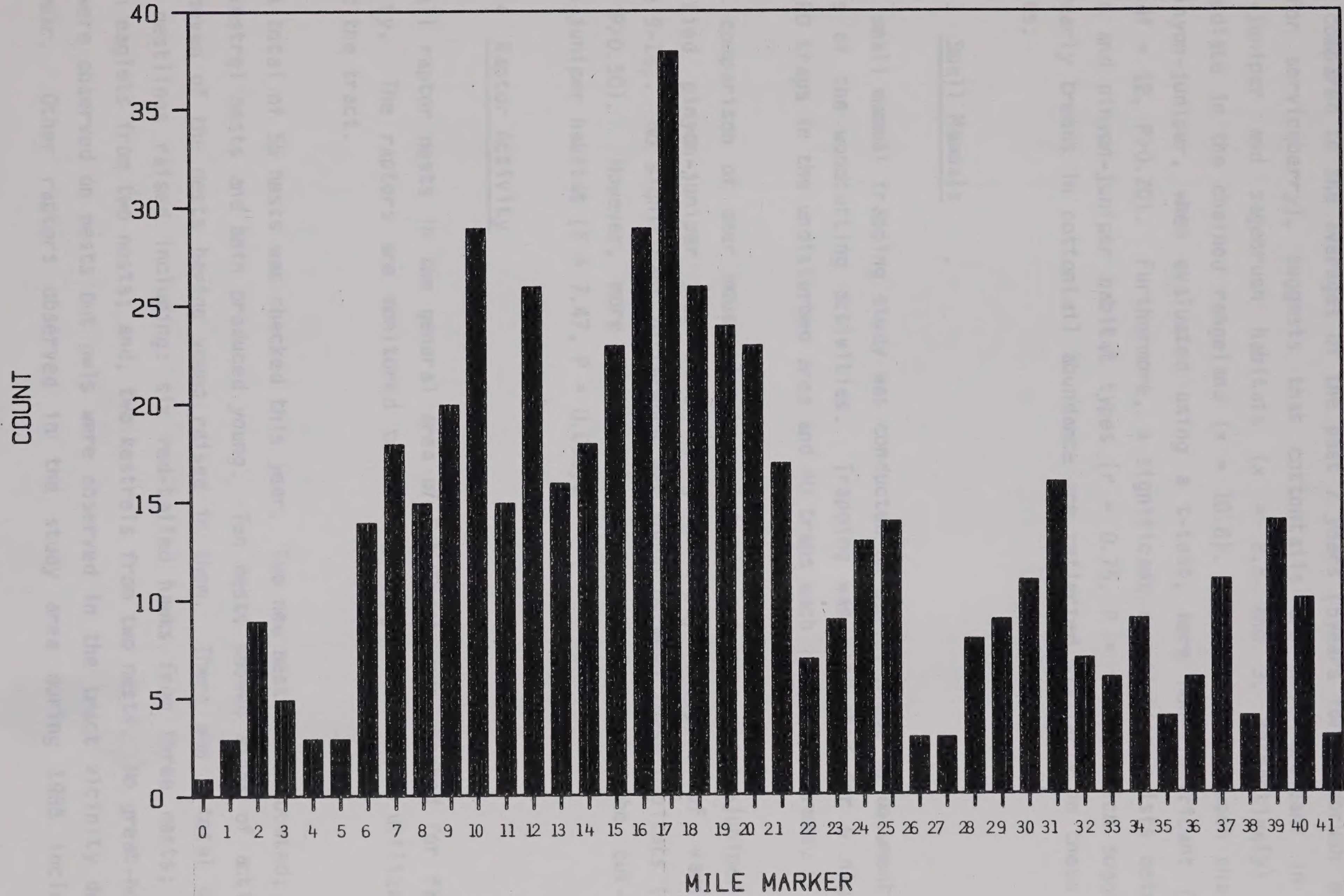
Date	Does		Fawns				Bucks		Unknown	Total
			Male		Female					
	No.	%	No.	%	No.	%	No.	%		
10-84 to 5-85	17	33	5	10	27	53	0	0	2	51
9-83 to 5-84	39	60	8	14	11	17	3	5	4	65
9-82 to 5-83	35	58	8	13	15	23	0	0	2	60
9-81 to 5-82	30	56	3	6	12	22	6	12	3	54
9-80 to 5-81	12	43	3	11	6	22	2	7	5	28
9-79 to 5-80	40	41	22	22	26	27	3	3	5	96
9-78 to 5-79	80	61	13	10	27	21	11	8	0	131
9-77 to 5-78	40	41	28	29	22	22	8	8	2	100*
TOTALS	293	50	90	15	146	25	33	6	23	585

*Total road kill was 125 deer. This figure was derived from combining DOW data with C-b data.

FIGURE 9-17

CUMULATIVE PICEANCE CREEK ROAD KILL

(1977 - 1985)



The relative abundance of cottontails in the 5 habitats sampled (Table 9-17), compared to the averages of the past 7 years (5years for sagebrush and 1 year for serviceberry), suggests that cottontails are most abundant in the pinyon-juniper and sagebrush habitats (x = 2.5 and 3, respectively) and intermediate in the chained rangeland (x = 10.6). Differences between chained and pinyon-juniper, when evaluated using a t-test, were non-significant (t = 1.19, df = 12, $P>0.20$). Furthermore, a significant correlation exists between chained and pinyon-juniper habitat types (r = 0.75, P = 0.05), which suggests that yearly trends in cottontail abundance are reflected similarly in these two habitats.

9.3.8.3 Small Mammals

A small mammal trapping study was conducted on Bailey Ridge to document any effects of the woodcutting activities. Trapping was conducted for 6 nights; using 80 traps in the undisturbed area and 40 traps each in two cut areas.

A comparison of deer mouse abundance between cut-over pinyon-juniper and unmodified pinyon-juniper was made using a 1-way analysis of variance (Table 9-18). No significant difference was found between these habitats (F = 0.83, $P>0.50$). However, more Uinta chipmunks were found in the cut-over pinyon-juniper habitat (F = 7.47, P = 0.002).

9.3.8.4 Raptor Activity

All raptor nests in the general area of C-b Tract were checked for raptor activity. The raptors are monitored to detect changes in raptor utilization around the tract.

A total of 55 nests was checked this year. Two new nests were located; both were kestrel nests and both produced young. Ten nests showed signs of activity with seven of the nests having young raised in them. There was a total of 12 young nestlings raised including: six red-tailed hawks from three nests; four golden eaglets from two nests; and, two kestrels from two nests. No great-horned owls were observed on nests but owls were observed in the tract vicinity during the year. Other raptors observed in the study area during 1985 included:

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9.3.8.3 Small Mammals

A small mammal trapping study was conducted on Gatley Ridge to document any effects of the woodcutting activities. Trapping was conducted for 6 nights; using 80 traps in the undisturbed area and 40 traps each in two cut areas.

A comparison of deer mouse abundance between cut-over pinyon-juniper and unmodified pinyon-juniper was made using a 1-way analysis of variance (Table 9-18). No significant difference was found between these habitats (F = 0.83, P>0.50). However, more uinta chipmunks were found in the cut-over pinyon-juniper habitat (F = 7.47, P = 0.002).

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TABLE 9-17 Cottontail trends based on pellet count frequencies.[1]

Year	HABITAT					
	Chained rangeland	Pinyon-juniper	Brush-beaten sagebrush	Sagebrush control	Serviceberry beating	Serviceberry beating
1978-79	8+/-1.2 (18)	11+/-1.6 (12)	-	-	-	-
1979-80	12+/-0.9 (15)	11+/-1.3 (12)	-	-	-	-
1980-81	9+/-0.7 (18)	13+/-0.8 (12)	3+/-0.9 (4)	12+/-3.1 (5)	-	-
1981-82	7+/-1.0 (18)	11+/-1.4 (12)	1+/-0.4 (4)	9+/-2.7 (5)	-	-
1982-83	13+/-1.0 (18)	15+/-0.8 (12)	3+/-1.3 (4)	14+/-2.1 (5)	-	-
1983-84	16+/-0.6 (15) -	15+/-1.0 (12) -	6+/-0.9 (4) -	17+/-1.7 (5) -	14+/-4.0 (3) (Pre-treatment)	11+/-0.88(3) (Pre-treatment)
1984-85	9+/-0.9 (18) -	10+/-1.0 (13) -	2+/-1.4 (4) -	8+/-1.9 (5) -	2+/-0.6 (3) (Pre-treatment)	3+/-1.4 (3) (Pre-treatment)

1 Data are means +/-SE (n). Means are based on the number of quadrats with droppings present; n = number of transects. A transect is 20 circular quadrats, 0.001 acre each.

TABLE 9-18 Relative abundance of small mammals, 1985.[1] Actual number of animals captured is shown in parentheses. Sample Size: Location No. 1, 480 trap-nights; Location Nos. 2 & 3, 240 trap-nights each.[2].

Species	SAMPLING LOCATIONS 1 Bailey Ridge	2 Veg Plot #6	3 SG-18
Deer Mouse <u>Peromyscus maniculatus</u>	16.3 (78)	13.8 (33)	12.5 (30)
Uinta Chipmunk <u>Eutamias umbrinus</u>	7.3 (35)	13.3 (32)	17.1 (41)
Montane Vole <u>Microtus montanus</u>	0	0	0.4 (1)
Long-tailed Vole <u>Microtus longicaudus</u>	0	0.4 (1)	0
Golden-mantled Ground Squirrel <u>Spermophilis lateralis</u>	0.2 (1)	0	0.8 (2)

1 Relative abundance = number of captures / number of trap-nights x 100.
2 A trap-night is one trap set one night.

Cooper's Hawk, sharp-skinned hawk, golden eagle, bald eagle, and numerous ravens.

No threatened or endangered plants or wildlife species were observed on tract with the exception of the usual sightings of bald eagles during the winter months and sandhill cranes flying through the area during their spring and fall migrations.

9.3.8.5 Avifauna

Avifauna studies (including morning doves) were conducted in the pinyon-juniper woodland habitat to detect possible effects of the illegal woodcutting activities on Bailey Ridge. Transects number 2, 4 and 6 were sampled three times each (same sampling design as in previous studies). Transect 6, in a new control site established on Bailey Ridge to replace control transect 4, was the site of some woodcutting activities.

The 1985 studies showed the highest density of birds for any of the six years the studies have been conducted (Table 9-19). As usual, transect 4 had the highest total density per hectare (8.76) which was an 18% increase over the previous high. Morning dove estimates are listed in Table 9-20. The morning dove population has never been large but seems to remain stable.

The Shannon-Weiner Indices of Diversity is presented in Table 9-21. No significant differences were observed.

The Hutchenson's T-test was used to test the null hypothesis that there is no difference in population diversity of species between control and developmental transects. The null hypothesis was accepted for both 2 vs. 4 and 4 vs. 6.

At present, there is no significant differences between species abundance, density or species diversity on the control or developmental transects.

Casual observations noted higher avifauna use in the woodcutting area. This was probably due to the larger areas of edge habitat on transect 4.

TABLE 9-19 Total Density Values for Avifauna Transects at C-b During Spring Sample Period, 1977 - 1985

Transect	Vegetation Type	Year	Total Density/Ha
1 (BH01)	Chained Pinyon-Juniper Rangeland (Control)	1977	2.82
		1978	3.11
		1979	3.19
		1980	2.94
		1981	2.44
2 (BH02)	Pinyon-Juniper Woodland (Developmental)	1977	5.34
		1978	2.51
		1979	2.63
		1980	2.75
		1981	2.06
		1985	5.93
3 (BH03)	Chained-Juniper Rangeland (Developmental)	1977	3.51
		1978	4.90
		1979	3.00
		1980	3.44
		1981	2.32
4 (BH04)	Pinyon-Juniper Woodland (Control)	1977	7.4
		1978	4.82
		1979	3.70
		1980	4.19
		1981	3.19
	Disturbed by Woodcutters.................	1985	8.76
5 (BH05)	Pinyon-Juniper Rangeland (Developmental-Sprinkler)	1980	2.51
		1981	2.63
6 (BH06)	Pinyon-Juniper Woodland (New Control for 4)	1985	4.37

TABLE 9-20 Morning Dove Estimates at Tract C-b for Spring Sampling Periods, 1977 - 1985

Transect	Date	Observations	Coefficient Detectability	Density /Ha	% Relative Abundance
Chained Pinyon-Juniper (BH01)	1977	2	1.00	.03	2.5
	1978	1	1.00	.02	0.9
	1979	1	1.00	.04	1.2
	1980	3	1.00	.19	6.4
	1981	0	1.00	.00	0.0
Pinyon-Juniper (BH02)	1977	4	1.00	.07	1.7
	1978	0	0.74	.00	0.0
	1979	3	0.74	.14	5.2
	1980	3	0.74	.19	6.84
	1981	2	0.74	.125	6.06
	1985	1	0.74	.51	5.82
Chained Pinyon-Juniper (BH03)	1977	2	1.00	.03	2.1
	1978	0	1.00	.00	0.0
	1979	0	1.00	.00	0.0
	1980	0	1.00	.00	0.0
	1981	0	1.00	.00	0.0
Pinyon-Juniper (BH04)	1977	17	1.00	.29	5.9
	1978	5	0.74	.17	4.2
	1979	0	0.74	.00	0.0
	1980	0	0.74	.00	0.0
	1981	0	0.74	.00	0.0
Disturbed by Woodcutters..	1985	1	0.74	.69	11.64
Sprinkler Area (BH05)	1980	0	0.74	.00	0.0
	1981	0	0.74	.00	0.0
New Pinyon-Juniper Control for BH04 (BH06)	1985	0	0.74	.00	0.0

TABLE 9-21 Shannon-Weiner Indices of Diversity, 1977 - 1985

Transect	Vegetation Type	Year	H	H Max	J
1	Chained Pinyon-Juniper Rangeland (Control)	1977	1.494	2.079	0.718
		1978	1.665	2.398	0.694
		1979	1.166	1.792	0.651
		1980	2.025	2.489	0.815
		1981	1.482	1.946	0.761
2	Pinyon-Juniper Woodland (Developmental)	1977	2.469	2.890	0.854
		1978	2.398	2.708	0.886
		1979	2.272	2.485	0.914
		1980	2.425	2.639	0.919
		1981	2.084	2.397	0.869
		1985	2.619	2.833	0.924
3	Chained-Juniper Rangeland (Developmental)	1977	1.950	2.197	0.888
		1978	1.885	2.398	0.786
		1979	1.526	1.946	0.784
		1980	2.271	2.708	0.839
		1981	1.599	2.197	0.728
4	Pinyon-Juniper Woodland (Control)	1977	2.740	2.944	0.931
		1978	2.545	2.890	0.881
		1979	2.189	2.398	0.913
		1980	2.463	2.944	0.837
		1981	2.307	2.639	0.874
		1985	2.496	2.833	0.881
5	Chained Pinyon-Juniper Rangeland (Irrigation Sprinkler System) (Control)	1980	2.197	2.639	0.832
		1981	1.595	2.079	0.767
6	Pinyon-Juniper Woodland (Control - replaces #4)	1985	2.460	2.891	0.851

NOTES:

(1) H is an estimate of H which is a measure of diversity developed by Shannon.

(2) H max is an estimate of H max which is a measure of the maximum possible diversity for a set of data consisting of k categories.

(3) J is an estimate of J which is termed evenness, homogeneity or relative diversity.

9.3.9 Vegetation

Vegetation monitoring studies have been conducted on the C-B Tract since 1975. These studies have focused on monitoring trends in herbaceous production and changes in community structure and species composition in the four major plant communities on the Tract. The monitoring studies prior to 1977 were described as Baseline studies, since they were conducted prior to any construction. From 1978 to 1981, the monitoring studies followed the Development Monitoring Program submitted and approved by the Area Oil Shale Office in Grand Junction. In 1982 the monitoring studies (Interim Monitoring Program) were scaled down in conjunction with a delay in construction activities.

During the 1985 reporting period the monitoring studies consisted of production and utilization studies in the chained rangeland vegetation type and community structure and composition studies at the pinyon-juniper woodland intensive study sites. This sampling and analysis was deemed necessary because of the illegal woodcutting which occurred on Bailey Ridge during 1984. Woodcutters removed all trees from Plot 6-0 (this is the unfenced veg. plot at Intensive Site 6). This required Plot 6-0 to be relocated to an undisturbed area nearby. Since the Intensive Study Sites are used as long-term monitoring sites and are considered to represent baseline vegetative conditions, it was decided (by CB, OSPO, and BLM) to sample these sites in 1985, and thus re-establish baseline information for this vegetation community type. Both open and fenced plots were sampled at each site in order to establish new similarity indexes between the undisturbed plots and the new plot, 6-0.

The methods used in these studies are consistent with past years and therefore, will not be described here. (See 1979 C-b Annual Report for a complete description of methods used.)

Results and Discussion. The January 31, 1986, CB Data Report, Volume III, Section 1.5.4 contains the vegetation monitoring data.

Production and Utilization Studies. In 1985, production and utilization studies were restricted to the chained rangeland vegetation type. Data was obtained from both range cages and adjacent open areas.

Mean total production (dry weight) was 23.5 g/m^2 (210 lbs/acre) in the open areas and 42.5 g/m2(379 lbs/acre) inside the range cages. Based on a one-way analysis of variance these two means are significantly different at a 0.05 level of significance (the critical region for this test is when the F-value is greater than 4.21, the calculated F for this test was 6.97). Based on data from the range cages, the production in the chained rangeland type was comparable to the results obtained in earlier years (Figure 9.3.9-1), and was very similar to the values obtained in the years between 1979 and 1982 when production ranged between approximately 42 and 46 grams per square meter. In 1978, 1983 and 1984 mean production in the chained rangelands was greater than 60 g/m^2 (Figure 9-18). It is interesting to note that the years with higher production estimates correspond to years with higher amounts of precipitation. Earlier studies by CB show a direct correlation between precipitation and herbaceous production (see 1979 and 1980 CB Annual Reports, Section 12.3).

Utilization of the herbaceous production in the chained rangeland type was approximately 55 percent. This value is the highest estimate of utilization observed. It is slightly higher than results from the past three years (50) percent in 1984, 49 percent in 1983 and 43.4 percent in 1982). As was noted in last year's report, utilization estimates have been higher the past few years. These increases in utilization are likely to be a result of range improvement practices implemented by the permittees and CB personnel. These improvements include water developments and fencing which results in better distribution of cattle and more efficient use of the range resource.

Community Structure and Composition (Intensive Study Sites). The primary reasons for sampling the pinyon-juniper woodland intensive study plots were to establish a new Plot 6-0 and to evaluate the similarity of the new plot with the other pinyon-juniper plots. Locating a new site for Plot 6-0 presented

Production and Utilization Studies. In 1985, production and utilization studies were restricted to the chained rangeland vegetation type. Data was obtained from both range cages and adjacent open areas.

Mean total production (dry weight) was 23.1 g/m^2 (210 lbs/acre) in the open areas and 42.5 g/m^2(379 lbs/acre) inside the range cages. Based on a one-way analysis of variance these two means are significantly different at a 0.05 level of significance (the critical region for this test is when the F-value is greater than 4.21, the calculated F for this test was 6.97). Based on data from the range cages, the production in the chained rangeland type was comparable to the results obtained in earlier years (Figure 9.3.9-11), and was very similar to the values obtained in the years between 1979 and 1982 when production ranged between approximately 42 and 45 grams per square meter. In 1978, 1983 and 1984 mean production in the chained rangelands was greater than 60 g/m^2 (Figure 9-10). It is interesting to note that the years with higher production estimates correspond to years with higher amounts of precipitation. Earlier studies by CB show a direct correlation between precipitation and herbaceous production (see 1979 and 1980 CB Annual Reports, Section 12.3).

Utilization of the herbaceous production in the chained rangeland type was approximately 55 percent. This value is the highest estimate of utilization observed. It is slightly higher than results from the past three years (50) percent in 1984, 49 percent in 1983 and 43.4 percent in 1982). As was noted in last year's report, utilization estimates have been higher the past two years. These increases in utilization are likely to be a result of range improvement practices implemented by the permittees and CB personnel. These improvements include water developments and fencing which results in better distribution of cattle and more efficient use of the range resources.

Community Structure and Composition (Intensive Study Sites). The primary reasons for sampling the pinyon-juniper woodland intensive study plots were to establish a new Plot 6-0 and to evaluate the similarity of the new plot with the other pinyon-juniper plots. Locating a new site for Plot 6-0 presented

Figure 9-18 Trends in mean herb production between 1978 and 1985 for the chained pinyon-juniper rangelands. Based on data from range cages.

some difficulty. The old site was in a pinyon-juniper stand on Bailey Ridge. The woodcutting activities removed all the trees in the surrounding areas. It was difficult to find a new site for Plot 6-0 that was comparable to Plot 6-F and was still in the immediate vicinity of the old Plot 6-0. After evaluating several alternate locations, a new site for Plot 6-0 was located approximately 150 meters north of Plot 6-F. The site has a slight east-facing exposure, and the understory is somewhat more sparse than the understory in Plot 6-F. As the data will show, the new Plot 6-0 is not as similar to Plot 6-F as the old Plot 6-0. These differences must be expected. It is important to note that the site that was chosen was the best available site on Bailey Ridge.

Herb layers in the four pinyon-juniper woodland study sites were sampled. These sites were last sampled in 1979. In general, the species composition on all previously sampled sites (Plots 5-0, 5-F, and 6-F) has not changed over the last 6 years. Minor differences in the amounts of annuals occur, however these are most likely related to differences in precipitation rather than to actual shifts in community structure. The species composition in new Plot 6-0 is comparable to that encountered in the other pinyon-juniper plots. The major species include mutton grass (<u>Poa fendleriana</u>), streambank wheatgrass (<u>Agropyron riparium</u>), and Hood's phlox (<u>Phlox hoodii</u>). These are also the three dominant species in Plot 6-F.

The similarity of the new Plot 6-0 with the other pinyon-juniper plots was evaluated using a similarity index based on frequency. This approach has been used in earlier CB monitoring reports. The highest similarity among the pinyon-juniper plots exists between Plots 5-0 and 5-F (70.5 percent). The second highest similarity exists between the new Plot 6-0 and Plot 5-0 (47.4 percent) followed by the similarity between Plots 6-0 and 6-F (46.3 percent). The new Plot 6-0 is more similar to Plot 5-0 than was the old Plot 6-0 but is less similar to Plot 6-F. Both Plot 5-0 and the new Plot 6-0 have east-facing aspects, however Plot 5-0 is on a steep east-facing slope whereas the new Plot 6-0 is only a slight east facing slope. The species composition and community structure on these sites may be responsible for the high similarity on these sites and may also be responsible for the reduced similarity between Plot 6-F and the new Plot 6-0. The lowest similarity values were for comparisons between Plot 6-F and Plot 5-F (21.8 percent and Plot 6-F and Plot 5-0 (23.2

some difficulty. The old site was in a pinyon-juniper stand on Bailey Ridge. The woodcutting activities removed all the trees in the surrounding areas. It was difficult to find a new site for Plot 6-0 that was comparable to Plot 6-F and was still in the immediate vicinity of the old Plot 6-0. After evaluating several alternate locations, a new site for Plot 6-0 was located approximately 150 meters north of Plot 6-F. The site has a slight east-facing exposure, and the understory is somewhat more sparse than the understory in Plot 6-F. As the data will show, the new Plot 6-0 is not as similar to Plot 6-F as the old Plot 6-0. These differences must be expected. It is important to note that the site that was chosen was the best available site on Bailey Ridge.

Herb layers in the four pinyon-juniper woodland study sites were sampled. These sites were last sampled in 1979. In general, the species composition on all previously sampled sites (Plots 5-0, 5-F, and 6-F) has not changed over the last 6 years. Minor differences in the amounts of annuals occur, however these are most likely related to differences in precipitation rather than to actual shifts in community structure. The species composition in new Plot 6-0 is comparable to that encountered in the other pinyon-juniper plots. The major species include mutton grass (Poa fendleriana), streambank wheatgrass (Agropyron riparium), and Hood's phlox (Phlox hoodii). These are also the three dominant species in Plot 6-F.

The similarity of the new Plot 6-0 with the other pinyon-juniper plots was evaluated using a similarity index based on frequency. This approach has been used in earlier CB monitoring reports. The highest similarity among the pinyon-juniper plots exists between Plots 5-0 and 5-F (70.6 percent). The second highest similarity exists between the new Plot 6-0 and Plot 5-0 (47.4 percent) followed by the similarity between Plots 6-0 and 6-F (46.3 percent). The new Plot 6-0 is more similar to Plot 5-0 than was the old Plot 6-0 but is less similar to Plot 6-F. Both Plot 5-0 and the new Plot 6-0 have east-facing aspects, however Plot 5-0 is on a steep east-facing slope whereas the new Plot 6-0 is only a slight east facing slope. The species composition and community structure on these sites may be responsible for the high similarity on these sites and may also be responsible for the reduced similarity between Plot 6-F and the new Plot 6-0. The lowest similarity values were for comparisons between Plot 6-F and Plot 5-F (21.8 percent and Plot 6-F and Plot 5-0 (20.2

percent). While these values are low, they are comparable to values obtained in earlier monitoring years.

Cover values in the pinyon-juniper intensive study plots have changed little over the past 10 years. The most noticeable change has occurred in Plot 5-F where cover by herbaceous species has increased from 9.3 percent in 1979 to 13.1 percent in 1985. Even this difference of 4 percent may be within the margin of sampling error and may not represent a real increase in cover. Other plots showed a decrease in total herbaceous cover over the period between 1979 and 1985. The new Plot 6-O has lower herbaceous cover values than the old Plot 6-O. Litter cover was less and cover by bare soil was greater. In all the previously sampled plots, species diversity has increased slightly. The new Plot 6-O has fewer species per square meter than the old Plot 6-O.

Shrub density and species composition in the new Plot 6-O is comparable to that in the other pinyon-juniper woodland intensive study plots. It is somewhat different from Plot 6-F in that big sagebrush is not as prevalent in the open plot as it is in the fenced plot. Over the last 10 years there have been few changes in the shrub layers at the intensive study plots. Cover values have fluctuated over the years, but no clear trends can be seen. Plot 5-F has increased slightly in shrub cover, but Plot 6-F has not had a consistent increasing trend. The new Plot 6-O has approximately the same mean shrub cover as the old Plot 6-O.

Tree canopy cover data show very little change over the past 10 years. The largest changes have occurred in Plot 5-O where canopy cover has increased from 30 to 39 percent during the 10 year period of observation. Plots 5-F and 6-F have changed very little. The new Plot 6-O has approximately the same canopy cover as the old Plot 6-O. The major difference is that the new plot has more Utah juniper than pinyon pine whereas the old plot had more pinyon than Utah juniper.

9.3.10 Revegetation

Revegetation monitoring studies for 1985 were conducted on three revegetation demonstration test plots, and on revegetated topsoil storage

embankments. The test plots include: 1) evaluation of revegetation success of raw (non-retorted) shale under three different topsoil treatments; 2) evaluation of revegetation success on Unishale B processed (retorted or spent) shale under different topsoil and sewage sludge application treatments; and, 3) evaluation of revegetation success on processed shale with a foot of topsoil cover over Lurgi processed shale, Unishale B processed shale with a subsurface compacted layer, and uncompacted Unishale B. A chemical analysis was also conducted on vegetation and soil samples from the two processed shale demonstration plots. The topsoil stockpiles were sampled to evaluate the success of revegetation on non-disposal disturbed sites. These sites were also set up in a paired-plot design in order to evaluate effects of cattle grazing on revegetated sites.

The objectives of the studies, along with descriptions of the design and construction, sampling methodologies used, and statistical analysis procedures, were discussed in detail in the 1984 CB Annual Report and will be omitted herein.

Results and Discussion. The data for the revegetation studies are presented in the January 31, 1986 CB Data Report, Volume III, Section 1.5.5.

9.3.10.1 Raw Shale Demonstration Plot

Mean total herbaceous cover was very consistent among the three topsoil treatments. Mean total cover ranged from 24.6 percent on the 18-inch topsoil treatment to 30.6 percent on the 12-inch topsoil treatment. Mean cover on the 6-inch topsoil treatment was 28.8 percent. The major species are the wheatgrasses (Agropyron cristatum, Agropyron intermedium, Agropyron spicatum, and Agropyron smithii). The wheatgrasses accounted for 43.8 percent, 41.8 and 69.9 percent of the total cover on the 6-inch, 12-inch, and 18-inch treatments, respectively. The other major species were alfalfa (Medicago sativa), smooth brome (Bromus inermis) and Russian wildrye (Elymus junceus) which accounted for most of the remaining cover on the three treatment blocks. Of the species that were planted, the wheatgrasses performed the best. Alfalfa has increased in its abundance on the 6-inch and 12-inch treatments. In 1985 it accounted for 49.2 percent of the total cover on the 6-inch treatment and 37.4 percent on the

embankments. The test plots include: 1) evaluation of revegetation success of raw (non-retorted) shale under three different topsoil treatments; 2) evaluation of revegetation success on Unishale B processed (retorted or spent) shale under different topsoil and sewage sludge application treatments; and, 3) evaluation of revegetation success on processed shale with a foot of topsoil cover over Lurgi processed shale, Unishale B processed shale with a subsurface compacted layer, and uncompacted Unishale B. A chemical analysis was also conducted on vegetation and soil samples from the two processed shale demonstration plots. The topsoil stockpiles were sampled to evaluate the success of revegetation on non-disposal disturbed sites. These sites were also set up in a paired-plot design in order to evaluate effects of cattle grazing on revegetated sites.

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9.3.10.1 Raw Shale Demonstration Plot

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12-inch treatment. Great Basin wildrye was not identified in the sampled quadrats in any of the treatments. Annual weeds comprised an insignificant component of the vegetation on the test plot.

The estimate of mean total production was highest in the 18-inch treatment, 91.7 g/m^2 (818 lbs/acre), followed by the 12-inch treatment, 87.6 g/m^2 (781 lbs/acre), and the 6-inch treatment, 84.5 g/m^2 (754 lbs/acre). The values for the 6-inch and 12-inch treatments are approximately the same as those measured in 1984. The 1984 values for the 18-inch treatment were approximately 23 g/m^2 higher than the 1985 values. It is clear that the gradient of values matches the topsoil depth gradient, however the production values for all treatments are separated by only 7.2 grams. The differences were tested using a one-way analysis of variance and were found to be in-significant. (The test was made at a 0.05 level of significance. The critical region for rejecting the hypothesis is for F values greater than 3.16. The calculated F value was 0.29). In 1983, the 18-inch treatment had significantly higher production than either the 6 or 12-inch treatments. In 1984 the differences were not significantly different. After three years of evaluation, the 18-inch treatment consistently has had the highest level of production. The differences, however, have not been significant over the last two growing seasons. It appears that similar comparable results can be obtained by using 6, 12, or 18 inches of topsoil over raw shale. These results suggest that 18 inches of topsoil may be preferable, however the differences are not statistically different after four growing seasons.

In all cases, the greatest percentage of total biomass was attributable to wheatgrass species. Crested wheatgrass (<u>Agropyron</u> <u>cristatum</u>), awnless bluebunch wheatgrass (<u>Agropyron</u> <u>spicatum</u> var. <u>inerme</u>) and intermediate wheatgrass (<u>Agropyon</u> <u>intermedium</u> var. <u>intermedium</u> and var. <u>trichophorum</u>) were the most productive of the wheatgrass species. On the 6-inch and 12-inch treatments, most of the remaining production was attributable to alfalfa. On the 18-inch treatment most of the remaining production came from Russian wildrye.

9.3.10.2 1983 Processed Shale Revegetation Demonstration Plot

This demonstration plot received approximately 3.5 inches of additional irrigation water during the 1985 growing season. The plot was also fertilized in the spring (April, 1985) with nitrogen and potassium fertilizers at the equivalent rate of 50 and 80 pounds per acre, respectively. This is the third growing season for this Plot and thus marks the third straight year of fertilization and irrigation. (See 1983 and 1984 Annual Reports for amounts.)

On the plots treated with sewage sludge, mean total herbaceous cover was consistently higher than the comparable topsoil depths without sewage sludge. On the plots treated with sewage sludge, mean total herbaceous cover ranged from 49.4 percent on the 6-inch topsoil treatment to 69.9 percent on the 18-inch treatment. On the treatments with no sewage sludge, mean total herbaceous cover ranged from 33.6 percent on the 6-inch treatment to 51.6 percent on the 18-inch treatment. With both the sewage sludge and no sewage sludge treatments, there was a consistent trend for increasing cover values with increasing amounts of topsoil. The differences in cover were not tested statistically, however, the results from the cover sampling closely parallel the results obtained from the production studies. On the plots treated with sewage sludge, the major species on all three treatments was smooth brome (Bromus inermis) with mean cover values of 47.6, 58.8, and 67.4 percent on the 6-, 12-, and 18-inch treatments, respectively. Russian wildrye occurred as a secondary dominant. The wheatgrass species accounted for less than 5 percent of the total cover. Weedy species comprised only a minor part of the total cover.

On the plots not treated with sewage sludge, smooth brome was also the dominant species. Cover by smooth brome was 25.2, 33.4, and 50.0 percent on the 6-, 12-, and 18-inch treatments, respectively. Mean total herb cover was 7 to 17 percent higher in 1984 compared with 1985.

In all treatments, most of the biomass was contributed by the smooth brome and other perennial grasses. Smooth brome was the overwhelming dominant in each of the treatment blocks. In the treatments with sewage sludge, mean total production was highest in the 18-inch treatment, 293.4 g/m^2 (2616 lbs/acre),

followed by the 12-inch treatment, 193.6 g/m^2 (1726 lbs/acre), and the 6-inch treatment, 161.6 g/m^2 (1441 lbs/acre). The mean production values increase with increasing topsoil depth. In the treatments without sewage sludge, mean total production was highest in the 18-inch treatment, 201.1 g/m^2 (1793 lbs/acre) followed by the 12-inch treatment, 147.2 g/m^2 (1313 lbs/acre) and the 6-inch treatment, 117.9 g/m^2 (1051 lbs/acre). In these treatments, mean production also follows the topsoil gradient. In all cases the treatments with sewage sludge had higher production than their corresponding treatments without sewage sludge. The significance of the differences among the different treatments was tested using a two-way analysis of variance. The results of the analysis (Table 9-20) show that the differences attributable to the sludge application were significant, and the differences attributable to topsoil thickness were also significant. The interaction of topsoil thickness and sewage sludge application was not significant. These results are consistent with the results obtained in 1983 and 1984 and suggest that total production can be significantly increased by the application of sewage sludge and by increasing the depth of topsoil. While these conclusions should be considered to be tentative, it appears that the differences related to topsoil depth and application of sewage sludge are real and may be very important relative to full-scale revegetation of processed shale disposal areas. It will be important to evaluate the treatments in subsequent years to see if the relationships noted in the last three growing seasons are consistent from year to year.

9.3.10.3 1984 Processed Shale Revegetation Demonstration Plot

The 1984 demonstration plot was constructed in August, 1984 making 1985 the first growing season for the plot. The plot was described in detail in the 1984 Annual Report.

During the past growing season the plot received approximately 3 inches of additional irrigation water. It was also fertilized in the spring with Nitrogen - Phosphate - Potassium fertilizer at the equivalent rate of 80-100-50 pounds per acre. (This was in addition to the P and K fertilizer applied at the time of construction at the equivalent rates of 400 and 80 pounds, respectively.)

followed by the 12-inch treatment, 193.8 g/m^2 (1728 lbs/acre), and the 6-inch treatment, 161.6 g/m2 (1441 lbs/acre). The mean production values increase with increasing topsoil depth. In the treatments without sewage sludge, mean total production was highest in the 18-inch treatment, 201.1 g/m2 (1793 lbs/acre) followed by the 12-inch treatment, 147.2 g/m2 (1312 lbs/acre) and the 6-inch treatment, 117.9 g/m2 (1051 lbs/acre). In these treatments, mean production also follows the topsoil gradient. In all cases the treatments with sewage sludge had higher production than their corresponding treatments without sewage sludge. The significance of the differences among the different treatments was tested using a two-way analysis of variance. The results of the analysis (Table 9-20) show that the differences attributable to the sludge application were significant, and the differences attributable to topsoil thickness were also significant. The interaction of topsoil thickness and sewage sludge application was not significant. These results are consistent with the results obtained in 1983 and 1984 and suggest that total production can be significantly increased by the application of sewage sludge and by increasing the depth of topsoil. While these conclusions should be considered to be tentative, it appears that the differences related to topsoil depth and application of sewage sludge are real and may be very important relative to full-scale revegetation of processed shale disposal areas. It will be important to evaluate the treatments in subsequent years to see if the relationships noted in the last three growing seasons are consistent from year to year.

9.3.10.3 1984 Processed Shale Revegetation Demonstration Plot

The 1984 demonstration plot was constructed in August, 1984 making 1985 the first growing season for the plot. The plot was described in detail in the 1984 Annual Report.

During the past growing season the plot received approximately 3 inches of additional irrigation water. It was also fertilized in the spring with Nitrogen - Phosphate - Potassium fertilizer at the equivalent rate of 60-100-60 pounds per acre. (This was in addition to the P and K fertilizer applied at the time of construction at the equivalent rates of 400 and 90 pounds, respectively.)

Table 9-22 Results of the two-way analysis of variance test for evaluating the effects of sewage sludge application and topsoil thickness on the processed shale demonstration plot. 1985 Data.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F	Significance
Subgroups					
A (Sludge)	1	110984.3	110984.3	31.950	SIG
B (Topsoil Thickness)	2	249832.8	12496.4	35.961	SIG
Interactions					
A x B (Sludge x Topsoil Thickness)	2	15110.2	7555.1	2.175	NS
Within (Error)	114	395999.1	3473.7		
Total	119	771926.0			

SIG = Significant $F_{0.05[1,114]} = 3.93$ $F_{0.05[2,114]} = 3.08$

NS = Not Significant

Sampling of the plot during 1985 was limited to soils and vegetation chemical analysis (discussed later) and visual inspection and observation (i.e., no in-depth sampling). This limited amount of sampling was done with OSPO concurrence, due to expected high amount of weeds the first year.

The plot was dominated, particularly from a visual standpoint, by annual weeds. The most prevalent weeds being annual Chenapodiums, Sisymbrium altissimum, Salsola, some Kochia and Bromus tectorum. However, upon closer inspection, there was a good stand of the seeded perennials emerging. Because these perennials were in the early growth stages, we did not want to damage them through more in-depth sampling procedures. The only seeded species which were not observed were Elymus cinereus, Hedysarum boreale, and Artemisia tridentata.

It is interesting to compare the first growing season's appearance of the two processed shale demonstration plots. The 1983 Demo Plot was, and still is, dominated by smooth brome (Bromus inermis), while the appearance of the 1984 Demo Plot more resembles other revegetated areas at the C-b Tract site. These revegetated areas are dominated by weedy annuals with a good "understory" mix of seeded perennials the first growing season. The seeded species begin to dominate the sites the second year, and by the third year these desired perennials have out-performed the annuals to the point where very few "weeds" are present. It will be interesting to see if the 1984 Demo Plot will follow this pattern in subsequent years. It was especially interesting and encouraging to note that there were several seedlings of both four wing saltbush (Atriplex canescens) and bitterbrush (Purshia tridentata). There has been no bitterbrush observed on the 1983 Demo Plot and only a few four wing seedlings, which haven't appeared to advance much past the seedling stage.

There are three possible explanations for the stark differences in appearance of the two plots during the first year's growing season. The first explanation could be the difference in the seed mixtures (less smooth brome was included in the 1984 Plot seed mix); and, the actual mixing of the seed which went onto the 1983 Plot is somewhat suspect. The second could be the time of seeding as the 1983 Plot was seeded in the Spring, while the 1984 Plot was seeded in the fall. The third explanation for differences could be a result of the fact that the 1983 Plot was watered heavily after seeding in an attempt to

make up for lost winter precipitation. While the 1984 Plot did not need to receive any additional irrigation until well into the growing season. The 1983 Plot received approximately 8.25 inches of additional water, while the amount of precipitation received in 1983 was above normal. The 1984 Plot received about 3 inches of additional water and the amount of precipitation in 1985 was closer to normal than was 1983. Past researchers have shown that revegetated plant communitites that receive supplemental irrigation and fertilization are dominated more by grasses at the expense of forbs and shrubs. It was much easier to control the amount of supplemental watering of the 1984 Plot due to the use of the neutron moisture probe in scheduling additional irrigation. (The 1983 Plot was irrigated whenever it "appeared" to be severely drying out.)

It will be important to limit supplemental irrigation on the 1984 Demo Plot in future years in order to allow the vegetation to compete under more "normal" conditions.

9.3.10.4 <u>Soils and Vegetation Chemical Analysis</u>

Vegetation and soil samples were collected from both the 1983 and the 1984 Demonstration Plots. Samples of the 1983 Plot were collected from the treatments consisting of 12 inches of soil over processed shale with and without sewage sludge. Samples of the 1984 Plot were taken from each of the three treatments. In addition to these samples, soil and vegetation samples were collected from a revegetated topsoil stockpile for use as a control. All samples were composite samples (i.e., small individual samples from different area, or plants, from within the treatment were combined and mixed for analysis). The analysis results are presented in the January 31, 1986 Data Report, Volume III, Tables 1.5.5-4 thru 1.5.5-6.

The concentrations of the major nutrients (N-P-K) in the vegetation samples from the demo plots, particularly the 1984 Plot, were significantly higher than samples from the control. This is likely a result of fertilization efforts on the demo plots. Other observations of the vegetation analysis include slightly higher concentrations of Magnesium and Sodium from the demo plots (no differences between the plots, or treatments) than the control, and slightly less concentrations of Iron, Manganese, and Copper from the demo plots than the control.

The concentrations of salts and selenium in all plant samples are all significantly less than generally recognized toxic concentrations. The one area of concern is that the Copper:Molybdenum ratio from the demo plots plant samples are all less than 2:1. This condition has the potential to cause molybdenosis in animals which graze these plants. This should be monitored closely in subsequent years to see if copper additions may be advisable.

The results of the soil sample analysis from the 1983 Demo Plot are very similar to last years, with the one exception of the increased levels of potassium. This is likely a result of the spring fertilization with Potassium which was mentioned in the previous section. There is a very slight increase in the conductivity and sodium absorption ratios from last year. This could indicate a slight upward movement of salts. Subsequent monitoring should help to further establish any possible trends.

Generally speaking, the concentration of salts and other minerals in the samples of the upper 12 inches (topsoil covering) from the 1984 Demo Plot are similar to those of the topsoil control. The levels of P & K are higher from the demo plot, likely a result of fertilization. The concentration of salts and the other constituents, except selenium, are much higher in the 12" - 18" depth interval for the demo plot as compared to the control. The concentrations for the 6" - 12" interval are also higher for some of the parameters.

It appears from the soil sample analysis that there has been a positive result from fertilization. It also appears there may be some upward migration of salts into the lower depths of the topsoil covering. Additional sampling will be needed to detect any possible trends in migration of salts.

9.3.10.5 <u>Topsoil Stockpiles</u>

The same four topsoil stockpiles which were sampled in 1983 were sampled again in 1984. The stockpiles were sampled for species composition, vegetative cover, herbaceous production, shrub cover and shrub density. The sampling methods used were consistent with those used for other vegetation monitoring studies in past years.

The description of the stockpiles, the objectives of the study, and the statistical analysis and tests used to evaluate the data all discussed in the 1984 Annual Report. The data are presented in the January 31, 1986, Data Report, Volume III, Section 1.5.5. The results of analysis are shown on Tables 9.24 and 9.25.

The estimated total herbaceous cover for the northwest pile (no grazing) was 61.2 percent with mean number of species per square meter of 3.3. Mean shrub cover was 0.75 percent with an estimated density of 378 individuals per hectare. The mean total herbaceous production was 200.7 grams/m^2 (1789 lbs/acre) dry weight. This is more than three times the amount of production which was found in the range cages in the chained rangeland vegetation type. Most of the herbacous cover and production was attributed to the wheatgrasses. Cicer milkvetch was the dominant forb. The majority of the shrub species ranged from 0.26-0.75 meters in height.

The southernmost pile (grazed) had a herbaceous cover value of 51.8 percent with 3.5 species/m^2. Shrub cover was estimated at 2.38 percent with an estimate of 916 individuals per hectare. Herbaceous production was estimated at 110.5 grams/m^2 (985 lbs/acre). The dominant species were the same as above.

The Environmental Services' shed pile (grazed) had a herbaceous cover value of 61.2 percent with 6.45 species/m^2. Shrub cover was 0.22 percent with 252 individuals per acre. The majority of shrubs were less than 0.25 meters in height. Total herbaceous production was 79.5 grams/m^2 (709 lbs/acre). The major species were the wheatgrasses and alfalfa.

The fab shop pile (no grazing) had a herbaceous cover value of 67.65 percent with a mean number of species per m^2 of 7.55. Shrub cover was less than 0.01 percent with an estimate of 227 individuals per acre. Total herbaceous production was 278.1 grams/m^2 (2479 lbs/acre). The major species are the same as above.

The most apparent effect (and possibly the only effect) grazing is having on these particular revegetated plant communities is on herbaceous production.

Table 9-23 One-way Analysis of Variance Results for Comparisons of Differences Among Paired-Piles (grazed vs. ungrazed) for Herbaceous Production, Plant Cover, Species Diversity, and Shrub Density. 1985 Data.

	Calculated F	Critical Region* (F>)	Significance**
Differences in Herbaceous Production			
Northwest Pile (Ungrazed) vs. Southern Pile (Grazed)	4.268	4.4139	NS
Fab Shop Pile (Ungrazed) vs. E/S Shed Pile	39.818	4.4139	SIG
Differences in Herbaceous Cover			
Northwest Pile (Ungrazed) vs. Southern Pile (Grazed)	5.4009	4.1020	SIG
Fab Shop Pile (Ungrazed) vs. E/S Shed Pile	43.48	4.1020	SIG
Differences in Species Diversity (# of species/m			
Northwest Pile (Ungrazed) vs. Southern Pile (Grazed)	0.2857	4.1020	NS
Fab Shop Pile (Ungrazed) vs. E/S Shed Pile	8.52	4.1020	SIG
Differences in Shrub Density (# of shrubs/40m^2)			
Northwest Pile (Ungrazed) vs. Southern Pile (Grazed)	5.86	4.1020	SIG
Fab Shop Pile (Ungrazed) vs. E/S Shed Pile	2.2222	4.1020	NS

* The critical region was set at the 0.05 level of significance.
**NS - No significant difference SIG = Significant difference
NOTE = Underlined stockpile in comparisons had the greater value.

Table 9-24 Estimated means for Herbaceous Production, Plant Cover, Species Diversity, and Shrub Density for the Topsoil Stockpiles. 1983, 1984, and 1985 Data.

Topsoil Stockpile	Herbaceous Production[1] (g/m^2)			Plant Cover[2] (%)			Species Diversity[2] (spp/m^2)			Shrub Density[2] ($\#/40m^2$)		
	1983	1984	1985	1983	1984	1985	1983	1984	1985	1983	1984	1985
Northwest Stockpile - seeded in 1978, and ungrazed.	232.12 a	208.67 a	200.7 a	30.35	58.80 a	61.2 a	5.65 a	5.35 a	3.3	1.65 a	1.65 a	1.5 a
Southern Stockpile - seeded in 1978, and grazed.	247.98	183.60	110.5	40.60	51.50 a	51.8 a	5.10 a	5.20 a	3.5	4.20 a	3.35 ab	3.6 ab
Fab Shop Stockpile - seeded in 1980, and ungrazed.	252.46 a	229.63 a	278.1 a	47.95	67.65 a	70.15 a	8.55 a	8.65 a	7.55 a	2.25	1.05	0.8
E/S Shed Stockpile - seeded in 1980, and grazed.	221.12	190.09	79.47	36.85 a	62.90	48.45 a	6.70 a	7.65 a	6.45 a	4.30 a	3.85 a	1.0

1 Herbaceous production was tested using the student's t-test with = 0.10.

2 Plant cover, species diversity, and shrub density were tested using paired t-test with = 0.10.

3 Values followed by the same letter are not significantly different between those respective years.

Herbaceous production has decreased significantly each year on the grazed stockpiles. It is not possible to determine, from this study, if this effect is from yearly grazing or from year to year grazing (i.e., is the reduction in production a result of the plants being set-back in the growth stage during the year, or is it because of a reduction in plant vigor caused by successive seasons of grazing use). Since there are no trends in cover and/or diversity it is suspected to be from yearly grazing. If this study is to be continued, it would be interesting to put range cages on the grazed piles. This would help determine if year to year grazing is having an impact on production and also enable the investigator to determine utilization on revegetation communities.

9.3.11 Special Projects

This section discusses two mitigation projects implemented by CB, and two mitigation related projects, or projects where the activities could be implemented by CB in future years. The two mitigation projects are the 1979 sagebrush beating in Gardenhire and Oldland Gulches north of the Piceance Creek Highway, and the 1984 serviceberry beating project south of C-b Tract. The other two projects are the reseeding of a wildfire burn area in a pinyon-juniper woodland on a ridge north of the highway, and a sagebrush beating and sagebrush burning project conducted by the BLM in Dry Creek, located west of C-b Tract.

9.3.11.1 Sagebrush Beating Project

Two sagebrush dominated gulches (Gardenhire and Oldland), north of C-b Tract, were brush beaten in 1979. This action was conducted as a mitigation project having the following objectives: (1) improve forage for wildlife and livestock, (2) reduce deer winter range use by livestock, and (3) reduce the number of deer roadkills in early spring.

Vegetation and wildlife studies were initiated in 1980. Vegetation studies included yearly monitoring of species composition and herbaceous production. Yearly vegetation sampling was discontinued following 1982 (three years following treatment), with the intent of sampling every third or fourth year in order to establish trends in the plant community and to estimate the effective life of the brush beating treatment.

Vegetation studies were not scheduled to be conducted in 1983 and 1984; however, a limited amount of sampling was done in Gardenhire Gulch and a portion of the Control Area.

The results of the 1985 sampling are similar to past years in that the treatment, or beaten, areas are significantly more productive in terms of herbaceous vegetation. Mean herbaceous production estimates were: Oldland Gulch treatment area 143.1 g/m^2 (1276 lbs/acre); Gardenhire Gulch treatment area 92.5 g/m^2 (824 lbs/acre); and the Control Area 50.7 g/m^2 (452 lbs/acre). The major species in the treatment areas of both gulches were western and intermediate wheatgrasses (Agropyron smithii and A. trichophorum), followed by needle and thread grass (Stipa comata) and crested wheatgrass (A. cristatum) in Oldland Gulch and crested wheatgrass and cheatgrass (Bromus tectorum) in Gardenhire. The major species in the Control Area were cheatgrass, western wheatgrass, and needle and thread grass.

Both treatment areas are being re-invaded by sagebrush plants. These sagebrush are young plants producing longer annual growth stems than older plants located in the Control Areas. Even with re-invasion, the treatment areas still have a much more open canopy than the non-beaten areas.

9.3.11.2 Serviceberry Brush Beating Project

A ridge above, and to the south of C-b Tract, the ridge between Scandard and West Stewart Gulches was brush beaten and seeded in the fall of 1984. The portion of the ridge which was beaten was dominated by dense stands of serviceberry (Amelanchier alnifolia). The treatment area is approximately 100 acres. The area was then broadcast seeded at the rate of about 5 lbs/acre. This seed mixture was made up of old, unused seed, which was primarily wheatgrasses, perennial ryegrass, Russian wildrye, and some forb seeds, and four wing saltbush, and bitterbrush.

This project was conducted as a mitigation project having similar objectives as the sagebrush beaten project discussed previously. These objectives are: (1) improve forage for wildlife, primarily deer and elk, (2) improve annual browse production and utilization by wildlife, and (3) improve and increase forage for livestock.

Vegetation studies were not scheduled to be conducted in 1983 and 1984; however, a limited amount of sampling was done in Garoenhire Gulch and a portion of the Control Area.

The results of the 1985 sampling are similar to past years in that the treatment, or beaten, areas are significantly more productive in terms of herbaceous vegetation. Mean herbaceous production estimates were: Oldland Gulch treatment area 143.1 g/m^2 (1276 lbs/acre); Garoenhire Gulch treatment area 92.5 g/m^2 (824 lbs/acre); and the Control Area 50.7 g/m^2 (452 lbs/acre). The major species in the treatment areas of both gulches were western and intermediate wheatgrasses (Agropyron smithii and A. trichophorum), followed by needle and thread grass (Stipa comata) and crested wheatgrass (A. cristatum) in Oldland Gulch and crested wheatgrass and cheatgrass (Bromus tectorum) in Garoenhire. The major species in the Control Area were cheatgrass, western wheatgrass, and needle and thread grass.

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This project was conducted as a mitigation project having similar objectives as the sagebrush beaten project discussed previously. These objectives are: (1) improve forage for wildlife, primarily deer and elk, (2) improve annual browse production and utilization by wildlife, and (3) improve and increase forage for livestock.

Wildlife studies were initiated in 1983 and were conducted for one year prior to treatment. Vegetation studies were initiated this year following the beating treatment. Three deer-use transects were established within the treatment area, and an additional three transects were established in non-beaten areas on the same ridge for use as controls. Vegetation transects and production/utilization plots were established along these deer-use transects in both the treatment and control areas.

Vegetation studies which were conducted during 1985 consisted of community structure and composition, percent cover estimates, frequency (species diversity), shrub density, and shrub structure (shrub height classification), and herbaceous production and utilization.

The sampling procedure for community composition differed somewhat from past sampling methods. In an attempt to better define and compare the vegetation communities of the treatment and control areas, three different sampling methodologies were used. First point intercept transects were used to estimate cover. This consisted of stretching a 100-foot steel tape between two stakes and lowering a sharpened steel pin through the vegetation every foot along the length of the tape. (Each transect thus consisted of 100 points.) A "hit" was recorded when the point of the steel pin intercepted vegetation. Estimates of shrub cover, herbaceous cover, and ground cover were made along each transect. Shrub cover was determined by addition of the total "hits" from shrub species, above 0.25 meters, along each transect. Herbaceous cover was estimated by addition of total "hits" from shrub species, below 0.25 meters, along each transect. Ground cover was estimated by addition of total "hits" by vegetation at ground level (defined as less than 1 cm in height), for all shrubs, forbs, and grasses, or by hits from litter, bareground, or rock. A total of ten point-intercept transects were run perpendicular to the deer use transects in both the treatment and control areas. Total mean cover estimates were determined by addition of the hits along all ten transects and then dividing this sum by 10.

The second sampling method, belt-transect, estimated shrub density from 4 meter by 10 meter transects. This method is the same one used for past studies

different height classes. A second estimate of shrub cover was made along these transects by the use of line-intercept method, which have been used and described in past reports. This was done to see how well the newly used point-intercept method correlated to the previously used line-intercept method. The two methods appeared to produce fairly consistent results, with only small differences in estimates.

Range cages were the thrid method of sampling. Herbaceous production, utilization, and species frequency were estimated from 10 pairs of range caged and adjacent open plots. Each individual plot was 1.0 meter square. This method of production/utilization estimating has been described in past reports. A total of 10 pairs of caged and open plots were randomly located along the deer use transects in both the treatment and control areas. Since the clipped vegetation in the plots were separated by individual species, frequency estimates (number of species per m^2) were made from these same plots. Since both caged and open plots could be used, a total of 20 $1.0m^2$ plots per acre were used to estimate frequency.

All data from the above described sampling are contained in the January, 1986 Data Report.

Results and Discussion

The only noticeable impact of the brush beating was on the shrub component of the vegetation community. The shrub density estimate was considerably less in the treatment area than the control area (10,639 individuals/hectare vs. 17,408 individuals/hectare, respectively). An even more significant impact was made on the structure of the shrub component. In the treatment area an estimate of 473 individuals/hectare of shrubs greater than 0.75 meters in height was observed, while the control area had an observed estimate of 3,462 individuals/hectare greater than 0.75 meters in height. The shrub cover estimate for the treatment area was 10.4%. The shrub cover estimate for the control was 41.8%.

The brush beating treatment appears to have had very litle impact on the herbaceous component of the vegetation community. The estimated mean herbaceous cover for the treatment area was 38.8%, compared to 33.9% for the control area. The slight increase in cover for the treatment area can be attribued to the increase in shrub cover in the herb layer (6.0% for the treatment vs. 0.7% in the control). The estimated mean ground cover by vegetation for the control area was 19.4% compared to 20.0% for the treatment area. The treatment area did have slightly more litter cover (57.9%) and less bareground (22.1%) than did the control area (51.3% and 29.3%, respectively).

The estimated mean production (estimated from the caged plots) was greater in the treatment areas than in the control area (64.03 g/m^2 vs. 50.14 g/m^2 or 571 lbs/ac. vs. 447 lbs/ac., respectively).

Very little, if any, utilization was observed in either the treatment or the control areas. This observation was made in the field (once cattle were allowed above the cross fence they moved quickly through this area to higher elevations) and is substantiated by the data.

The treatment area also appears to have a slightly more diverse community of vegetation than does the control area (17.3 spp/m^2 vs. 14.2 spp/m^2).

It does not appear that the seeding effort had any effect during this first growing. From past revegetation experience at the C-b Tract, any impact from seeding will be more noticeable in the second and third growing seasons.

Conclusions

From a wildlife habitat standpoint, the brush beating treatment appears to have had a positive impact. In particular, the annual browse production and overall availability of this production has a greater utilization potential. The brush beating has either eradicated, or at least broken down, the large stagnant clumps of serviceberry. Thus, plant reserves are allowed to go into annual production rather than plant survival and maintenance. The change in stature of the shrubs also provides easier access to the annual shoots. It will be interesting to see the results of next year's deer-use transects (deer use is determined in the spring, prior to the time of vegetation sampling).

The improvement in livestock grazing is not as apparent. Even though there was an overall increase in herbaceous production, less desirable species such as Lupine, false dandelion, and needle-and-threadgrass increased in production as well as the more desireable grasses and forbs. Subsequent years of sampling will help determine if the goal of improvement of livestock capacity has been met.

9.3.11.3 Reseeding of the Wildfire Burn Area

In September, 1983 a small wildfire burned approximately 10 acres of pinyon-juniper woodland on BLM land north of the Piceance Creek road. (This burn area is just northeast of Tract C-b and is located in T2S, R96W, Section 28.) CB received permission from the BLM to conduct an experimental seeding in the burn area. If the seeding proved successful, this action would be considered for a mitigation project, and similar actions of burning and reseeding (particularly in the chained areas) would be considered for future mitigation projects.

The burn was divided into 10 areas. Five areas (approximately 5 acres, or half the burn area) were broadcast seeded with the seed mixture listed in the 1984 Annual Report. This seed mixture was composed of species used in reclamation activities on Tract C-b. The other five areas, which were similar in slope and aspect, were not seeded and were set-up as control areas.

Three randomly located one m^2 quadrats were located in each of the 5 seeded and 5 unseeded areas. The vegetation in these plots was then clipped, separated by species, oven dried, and weighed. From this data estimates of production and species frequency were determined for the seeded areas and then compared to the unseeded areas in order to determine if seeding had proven successful.

The data are presented in the January 31, 1986 Data Report. The results of the data show that the production in the unseeded area, 76.9 g/m^2 (686 lbs/ac) was significantly greater than in the seeded area, 47.8 g/m^2

The improvement in livestock grazing is not as apparent. Even though there was an overall increase in herbaceous production, less desirable species such as lupine, false dandelion, and needle-and-threadgrass increased in production as well as the more desireable grasses and forbs. Subsequent years of sampling will help determine if the goal of improvement of livestock capacity has been met.

9.5.11.3 Reseeding of the Wildfire Burn Area

In September, 1983 a small wildfire burned approximately 10 acres of pinyon-juniper woodland on BLM land north of the Piceance Creek road. (This burn area is just northeast of Tract C-b and is located in T2S, R96W, Section 28.) CB received permission from the BLM to conduct an experimental seeding in the burn area. If the seeding proved successful, this action would be considered for a mitigation project, and similar actions of burning and reseeding (particularly in the chained areas) would be considered for future mitigation projects.

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The data are presented in the January 31, 1986 Data Report. The results of the data show that the production in the unseeded area, 75.9 g/m^2 (686 lbs/ac) was significantly greater than in the seeded area, 47.8 g/m^2

(426 lbs/acre). Species frequency was 5.6 spp/m^2 for both areas.

These results indicate that seeding has had a detrimental effect. However, this is very unlikely. The number of samples was insufficient to account for the variability of the site. Visual observations made during the time of sampling revealed very few plants that appeared to be the result of the seeding effort. Possible reasons for the lack of success from seeding include: 1) the seed was broadcast rather than drilled, therefore, it could have been blown or washed away from the seeded area; 2) the burn-out areas might not have been adequate for seed germination and/or plant growth; 3) the understory vegetation could have been sufficient to out-compete the seeded species; or 4) a combination of the above. At any rate, broadcast seeding at this rate in burned pinyon-juniper woodlands, with understory capable of producing greater than 400 lbs/acre is not recommended as a mitigation practice.

9.3.11.4 Sagebrush Beating and Burning Project

During the late summer of 1984, the BLM conducted a range improvement project in Dry Gulch, which is about 4 miles west of C-b Tract. This improvement project consisted of brush beating a portion of the sagebrush (Artemisia tridentata tridentata) dominated gulch and burning the sagebrush in another portion of the gulch.

In early spring 1985, members of the CB E/S staff randomly located a series of 10 pairs of range cages and adjacent open areas in each of the beating, burn, and unaffected areas of the gulch. The vegetation in these plots was then clipped, separated by species, oven dried, and weighed. Estimates of production, utilization, and species frequency were made for each of the three areas.

The objectives of the study were mainly to see what effects the two treatments, burning and brush beating, had on the vegetation community; in particular, herbaceous production, utilization, and composition.

Also, these treatment areas were not seeded and the Oldland/Gardenhire sagebrush mitigation project was seeded, an attempt to determine if reseeding should be done in conjunction with sagebrush eradication could be made.

The data from this sampling is contained in the January 31, 1986 Data Report, Volume III, Section 1.5.6.

Results and Discussion

The mean herbaceous production estimates (from the caged plots) for the two treatment and control areas are: brushbeating, 233.2 g/m^2 (2079 lbs/ac); burning, 62.1 g/m^2 (554 lbs/ac); control, 18.3 g/m^2 (163 lbs/ac).

The major species in the brushbeating were pennycress (Lepidium montanum), Great Basin wildrye (Elymus cinerius), annual Chenapodiums, and Russian thistle (Salsola iberica). While Great Basin wildrye contributed to 23% of total measured production, it had a frequency of only 20%. The other species contributed to over 70% of total measured production and each had frequency of 80-100%. The major species of the burn area, in terms of production, was Russian thistle which contributed 41% of total measured production, yet it had a frequency of only 20%. Other major species in the burn area were bluebunch wheatgrass (Agropyron spicatum var. inerme), western wheatgrass (A. smithii), cheatgrass (Bromus tectorum) and globemallow (Sphaeralcea coccinea). The major species of the control area were pennycress, sand dropseed (Sporobolus cryptandrus), and western wheatgrass.

To estimate herbaceous utilization, the production of the open plots was subtracted from the production of the caged plots. The data from plot #9 of the burned area was not figured into the amount of utilization because of the huge discrepancy in the amount of annual Chenapodium (the open plot had 217.36 g/m^2 and the caged plot had 0 g/m^2). With this data set excluded, the caged plots had a higher estimate of production than the open plots. The estimates for herbaceous utilization are: brushbeating 47%, burning 19%, and control 0% (half of the open plots had higher production than the paired caged

plot, and the overall total production was higher for the open plots).

The diversity (spp. number of species per square meter) of the brush beaten area (7.0) was slightly higher than the burned (4.6) and control areas (4.9).

It is difficult to reach conclusions based on one year's data. However, about 75% of this production in the brushbeating was from less desirable and less palatable weeds.

Burning nearly eradicated the sagebrush and the weedy species, (at least after one year). In fact, if the two plots that had Russian thistle were excluded (both these plots were in an area that was suspected of being brush beaten prior to burning), nearly 70% of the herbaceous production would have been from grasses. This also would have lowered the productivity of the burning to about twice that of the control.

The above observations are of particular interest when considering the data from the control area. The understory of the control area was very sparse, and dominated primarily with weeds. Pennycress accounted for over 50% of the total production. This is almost the same amount as observed in the brushbeating. It appears that while brush beating significantly reduces the amount of sagebrush, the species that dominate the understory are the species that dominate the site following treatment, only in much greater quantities.

Burning, on the other hand, not only eradicates the sagebrush and understory, but apparently eliminates much of the seed source. Therefore, the species which are found the following year are the perennials that existed (and whose root systems were not destroyed) prior to treatment. Since the understory of perennials prior to burning was sparse, so were the perennials following treatment were likewise. Even though the number of plants was low, few, they appeared more robust than those of the control, which would explain the doubling of production.

It is much more difficult to make observations concerning utilization. It appears that both treatments increased utilization. It is suspected that the reason the control areas were not apparently utilized is because these areas were small "islands" and bordered areas in the Gulch, which "opened up" dramatically by the two treatments; and therefore, the cattle did not graze in the shrub-dominated areas. It is presumed, based on the sparsity of the understory, that this gulch has a history of past over-use.

It would have been interesting to see what effect reseeding portions of the treatment areas would have had. In fact, reseeding the treatment areas of this type of gulch, with an appropriate seed mix and method of seeding (i.e., drill seeding following the burn, and broadcast seeding prior to beating) would be recommended. This recommendation is based on the lack of sufficient density of desirable species. If seeding had been done, an adequate and desirable seed source would have been available for germination and growth.

<u>Summary</u>

The results of the previous study, and to some extent, the reseeding of the serviceberry brushbeating and the wildfire reseeding projects, demonstrate the need to evaluate a site prior to initiating a treatment.

Prior to brushbeating and burning Dry Gulch, the area was dominated almost exclusively by big sagebrush. From a livestock grazing standpoint, a definite need for treatment was apparent. The beating and burning both accomplished the goal of reducing sagebrush density. However, a closer evaluation of the understory prior to treatment should have revealed the need for reseeding, along with brush eradication. Since reseeding was not done, the density of desired perennials was sparse (throughout the Gulch), and the seed source of weeds plentiful, this area is likely to remain a weed patch until sagebrush again dominates the site. Grazing will increase this likelihood.

The other two projects represent a completely opposite situation. In these areas there was sufficient density of herbaceous species that reseeding probably would not be necessary.

9.3.12 Ecosystem Interrelationships

No studies in this area were conducted in 1985 other than those noted under Special Projects, Section 9.3.11.

9.3.13 Items of Aesthetic, Historic, or Scientific Interest

Surface activity was limited in 1985 so that minimum or no impact on aethetics occurred. Good "housekeeping" is monitored by regular site inspections by the OSPO and by consistent alertness of the environmental on-site staff.

9.3.14 Health and Safety

Accident frequency analyses have been included in the semi-annual data reports to the OSPO. At C-b, based on 41,166 man-hours, there were no lost-time accidents. The site injury (incident) rate in 1985 was 0.0 (reportable accidents times 200,000/man-hour divided by hours of employee exposure). This is compared with four lost-time accidents in 1984, and an injury rate of 17.15.

9.3.15 Toxicology

Toxicological testing has been curtailed due to reduced on-site activity. Continuation of the toxicological program is planned when appropriate.

9.3.16 Data Management and Quality Assurance

Air data are incorporated in a computerized data base management system called RAMIS. The basic data report generated is a diurnal table of hourly-average values for each variable, excepting particulates which are measured every fourth day as a total. Monthly air reports are generated and incorporated in six-month data reports along with summary tables and graphs. Hourly values are also stored on a tape supplied to the OSPO; see Table 9-26. The data are downloaded from RAMIS to a PC and from a spread sheet the reporting and graphing are done.

Quality assurance for air data, daily zero- and span-checks are made to check for potential drifts. Monthly multipoint calibrations are made for all gaseous data. Third party quarterly audits (see discussion in Section 9.3.5) and data precision checks (see most recent data report) are part of the quality assurance program.

Water data are also incorporated in RAMIS, except streams data which are stored in the USG WATSTOR data base and interrogated by the Project's computer dial-up. Values are then incorporated in to the 6-month data reports to the OSPO and stored on 5 1/4" floppies as indicated in Table 9-25.

Split and spiked samplings are utilized on a fraction of the samples to enhance the quality of the water data.

9.3.17 Reporting

Annual reports are submitted to the OSPO during the anniversary month of the Lease (April). Semi-annual Data Reports are submitted on January 31 and July 31. Air quality data volumes in these reports are also submitted to EPA, Region VIII, and the Air Quality Control Division of the Colorado Department of Health. Hydrologic data are forwarded to the USGS in Denver to provide additional inputs for the regional groundwater modeling development.

TABLE 9-25

Status of the Automated Environmental Data Base

HYDROLOGY AND WATER QUALITY	
Water Quality	
Springs and Seeps	October 1974 thru November 1981
Alluvial Wells	October 1974 thru November 1981
Deep Bedrock Wells	October 1974 thru November 1983
Field Measurements	
Springs and Seeps	October 1974 thru February 1986
Alluvial Wells	October 1974 thru November 1981
Deep Bedrock Wells	October 1974 thru February 1986
Levels and Flows	
Well Levels	October 1974 thru February 1986
Spring Flows	October 1974 thru February 1986
Water Augmentation Plan	
Springs and Seeps	July 1979 thru January 1986
Deep Bedrock Wells	August 1979 thru January 1986
Precipitation	January 1979 thru December 1985
National Pollutant Discharge Elimination System	
Water Quality Data	July 1979 thru February 1986
Water Usage	June 1980 thru December 1985
Well Reinjection	March 1981 thru June 1982 (Discontinued)
Surface Stream Flows/WQ	June 1982 thru June 1985
AIR QUALITY	
Air Quality Trailer AB23	October 1974 thru December 1985
Trailer AB20	October 1974 thru January 1982
Trailer AB26	October 1981 thru March 1982
Meteorological Tower AA23	October 1974 thru December 1985
Weather Station AD20	February 1982 thru July 1982
Station AD42	October 1974 thru March 1982
Station AD56	October 1974 thru August 1980
VISIBILITY	
Telephotometric	September 1975 thru June 1985
Photographic (Discontinued)	September 1975 thru October 1982
Traffic	February 1980 thru February 1986
Biology	
Microclimate	October 1974 thru January 1986
Deer Kill	October 1977 thru January 1986
Deer Count	September 1977 thru January 1986
Avifauna	1977 thru 1981

10.0 REFERENCES

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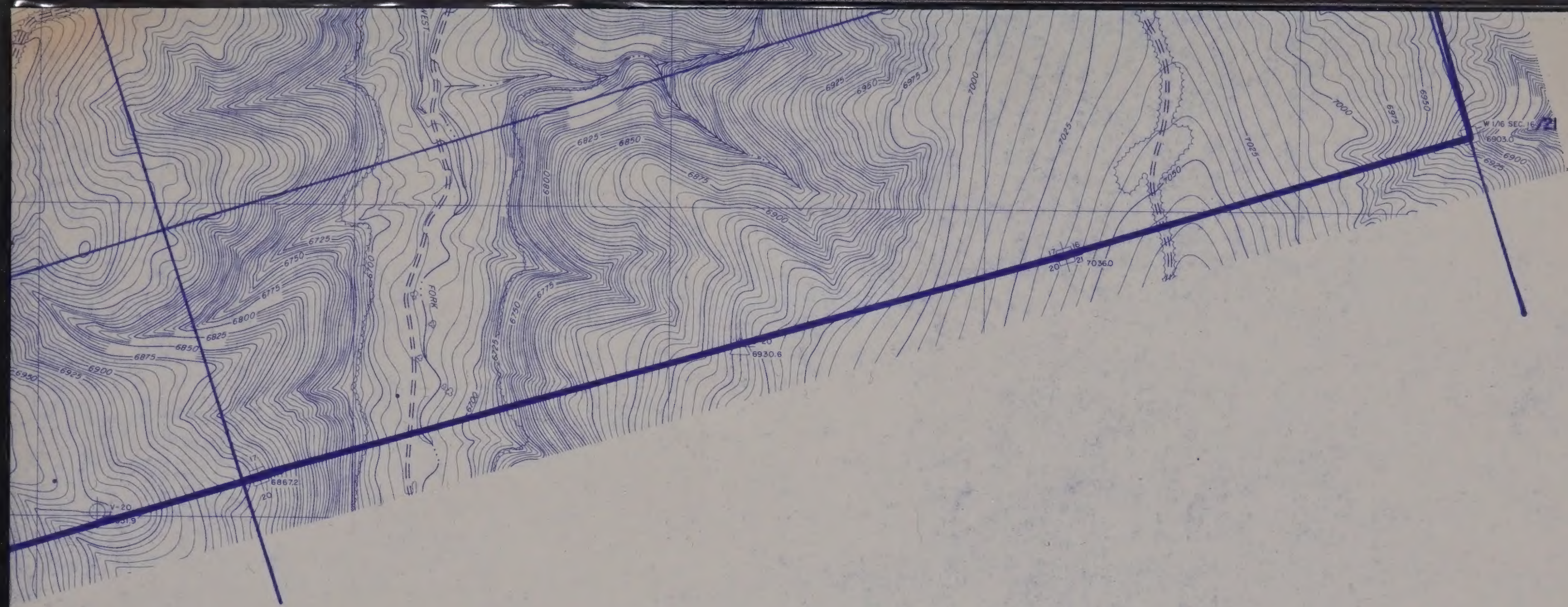

AD-0018	AREA MASTER INDEX
DWG. No.	DESCRIPTION
REFERENCE	DRAWINGS

TITLE

FIGURE 4-1
C-b TRACT
TOPOGRAPHIC MAP

Cathedral Bluffs Shale Oil Company

APPROVALS	PROJECT No. ESF-13.3	SCALE 1" = 600'	DRAWING No. AD-0017	REV. P

E

FOLD

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A

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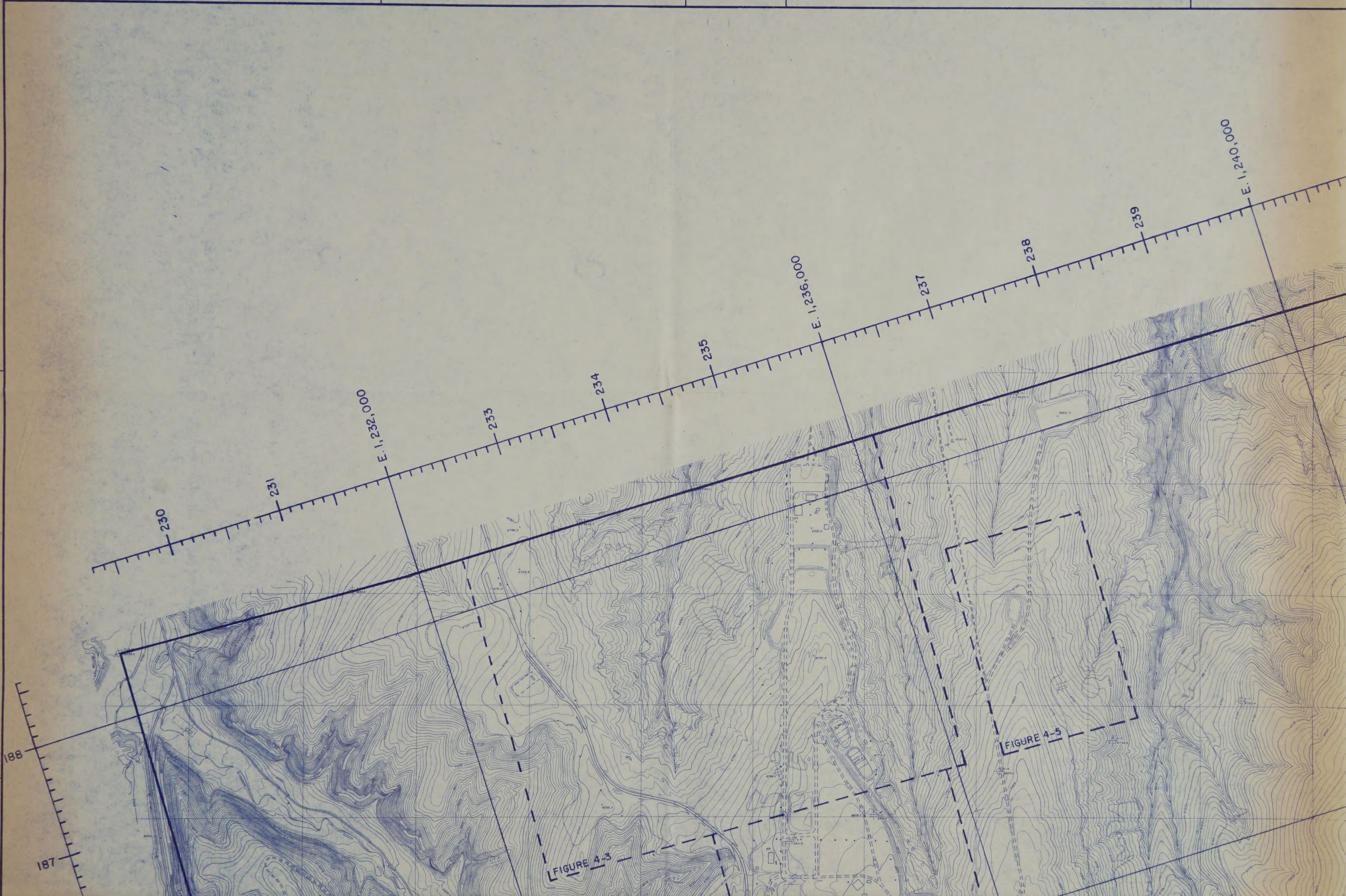
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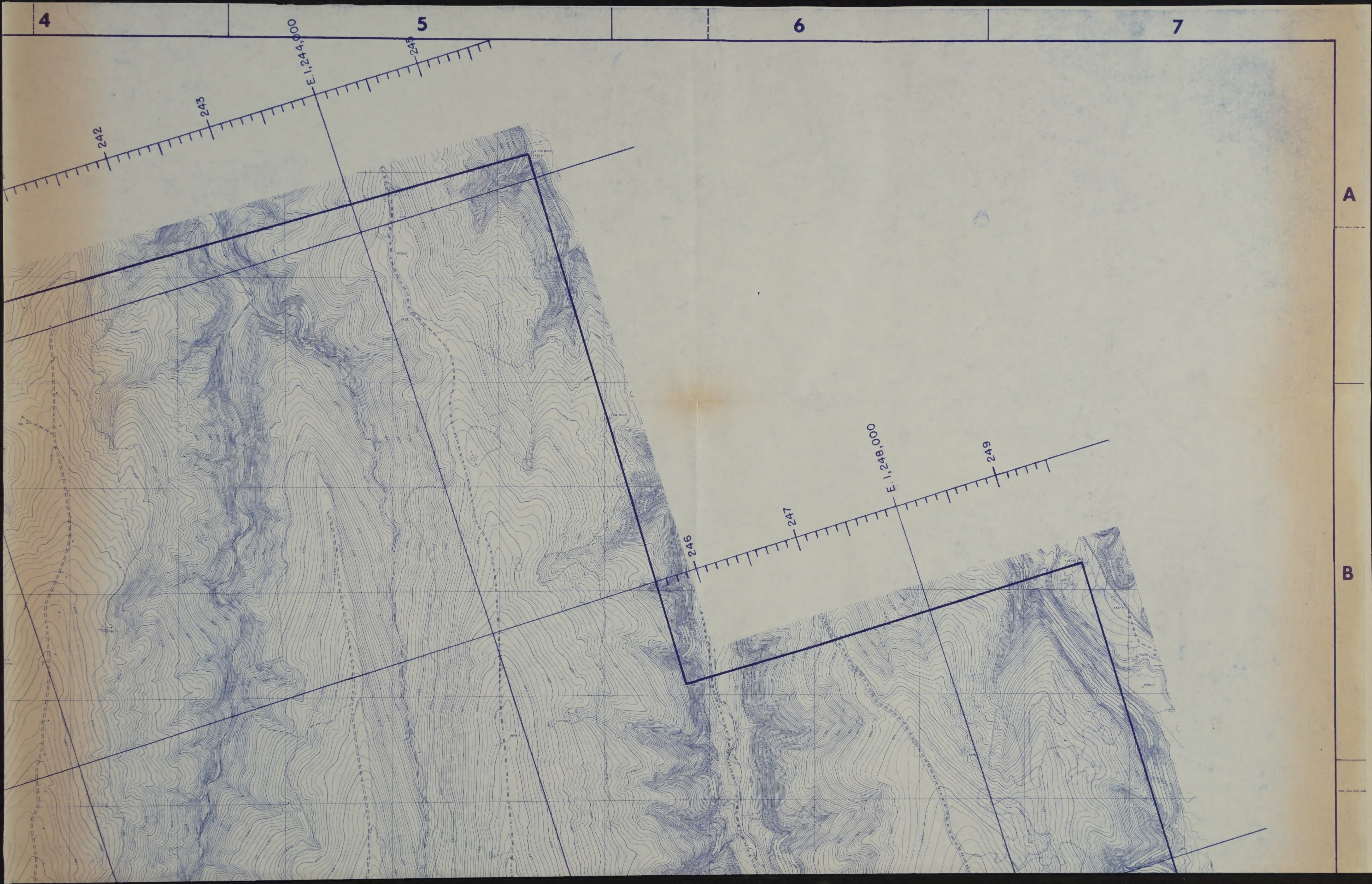
FIGURE 4-3
FIGURE 4-5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E.1,248,000
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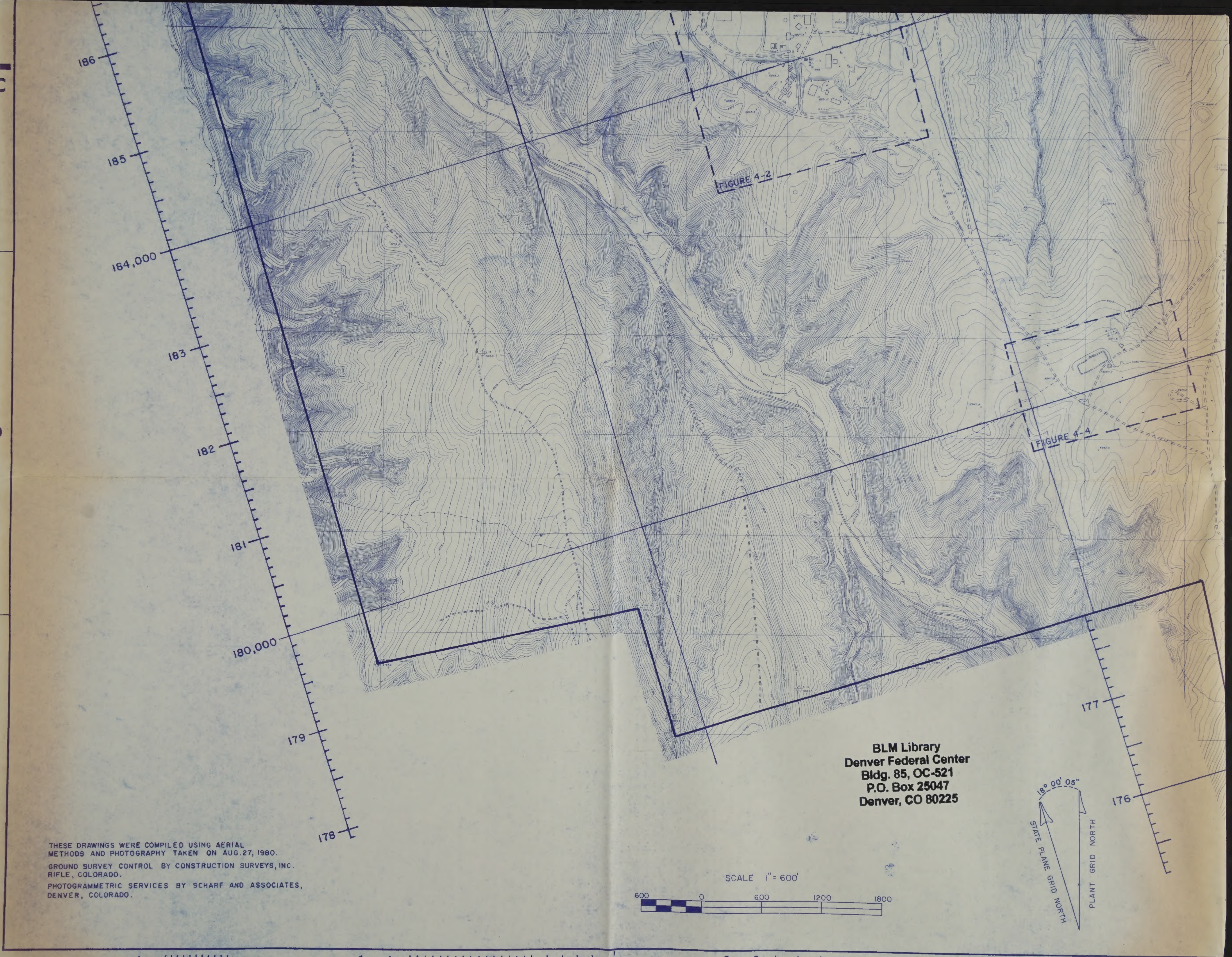
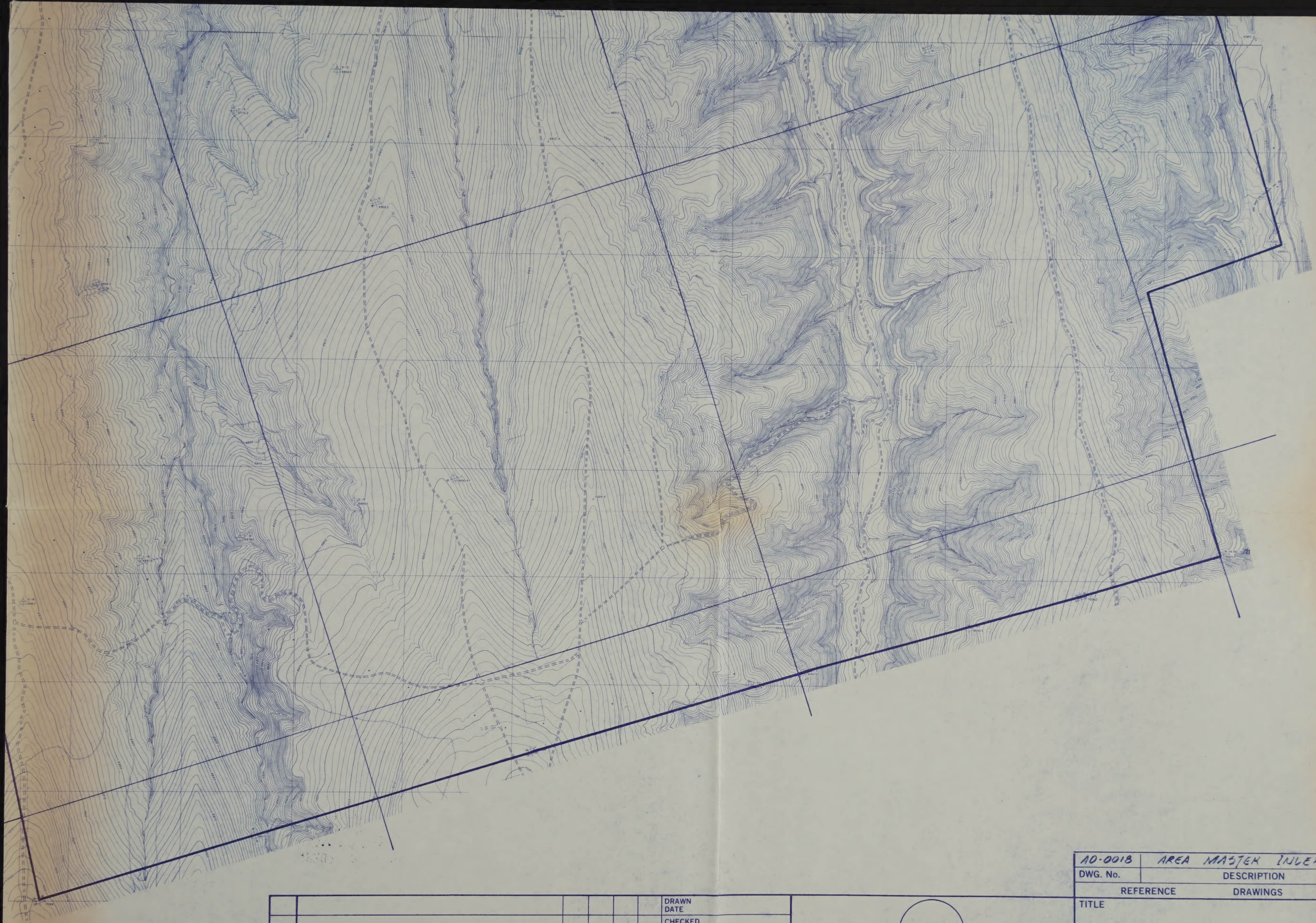


THESE DRAWINGS WERE COMPILED USING AERIAL METHODS AND PHOTOGRAPHY TAKEN ON AUG. 27, 1980.

GROUND SURVEY CONTROL BY CONSTRUCTION SURVEYS, INC. RIFLE, COLORADO.

PHOTOGRAMMETRIC SERVICES BY SCHARF AND ASSOCIATES, DENVER, COLORADO.



REV.	DESCRIPTION	DRAWN	DATE	CHK'D.	APPR.	APPROVALS
1	GRID & FIGURE Areas Outlined	VS	4/1/82			

DRAWN DATE
CHECKED DATE
APPROVED ENG.
APPROVED
APPROVED

Cathedral Bluffs Shale Oil Company

PROJECT No. ESF-13.3

SCALE 1" = 600'

DWG. No.	DESCRIPTION
AD-0018	AREA MASTER INDEX

REFERENCE DRAWINGS

TITLE

FIGURE 4-1
C-b TRACT
TOPOGRAPHIC MAP

DRAWING No. AD-0017

REV. P

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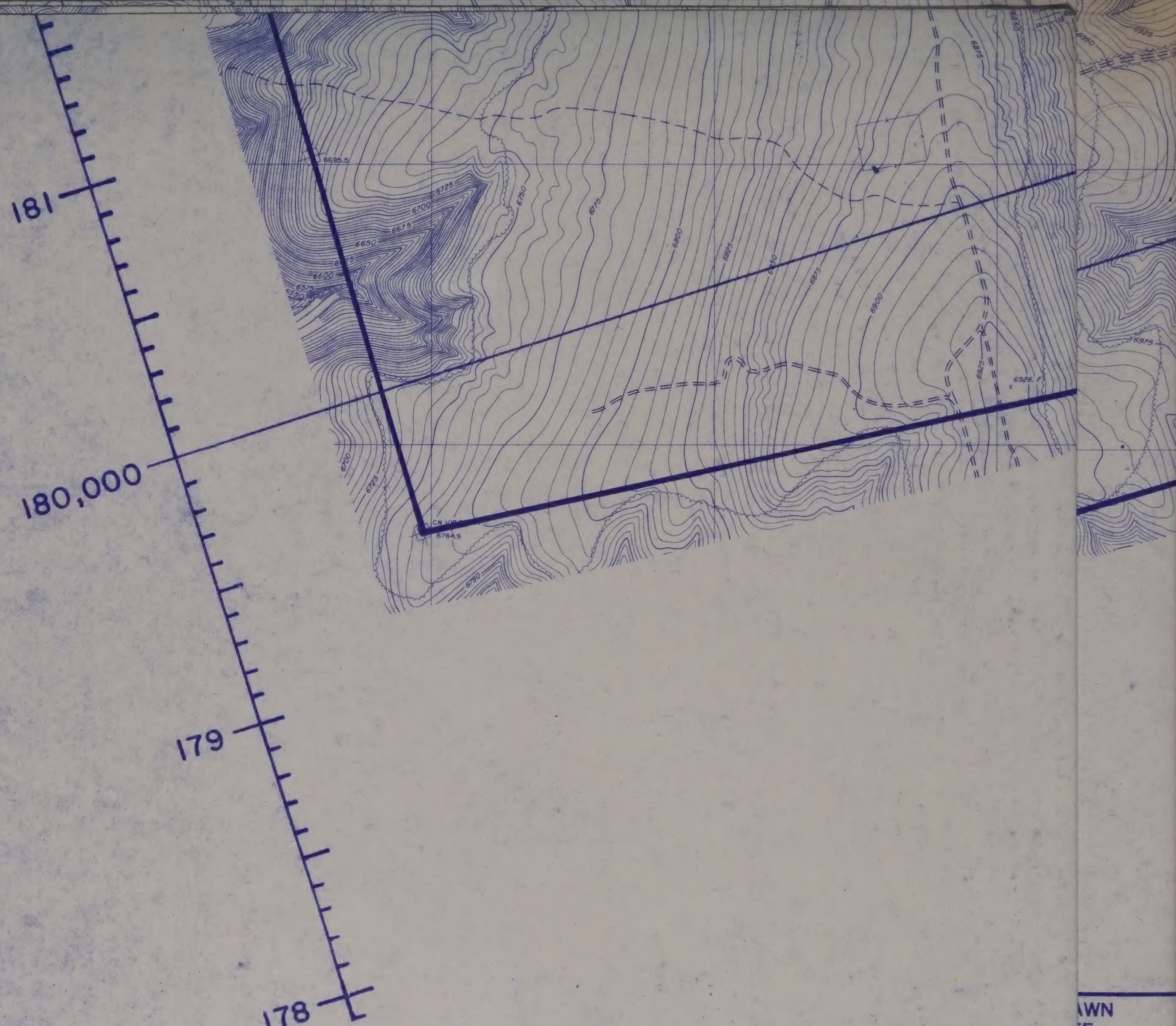

THESE DRAWINGS WERE COMPILED USING AERIAL
METHODS AND PHOTOGRAPHY TAKEN ON AUG.27, 1980.

GROUND SURVEY CONTROL BY CONSTRUCTION SURVEYS, INC.
RIFLE, COLORADO.

PHOTOGRAMMETRIC SERVICES BY SCHARF AND ASSOCIATES,
DENVER, COLORADO.

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